Vol. XVII, No. 12
June, 1961

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INDUSTRIAL QUALITY CONTROL

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QUALITY through Scientific Methods

JOURNAL OF THE AMERICAN SOCIETY FOR QUALITY CONTROL

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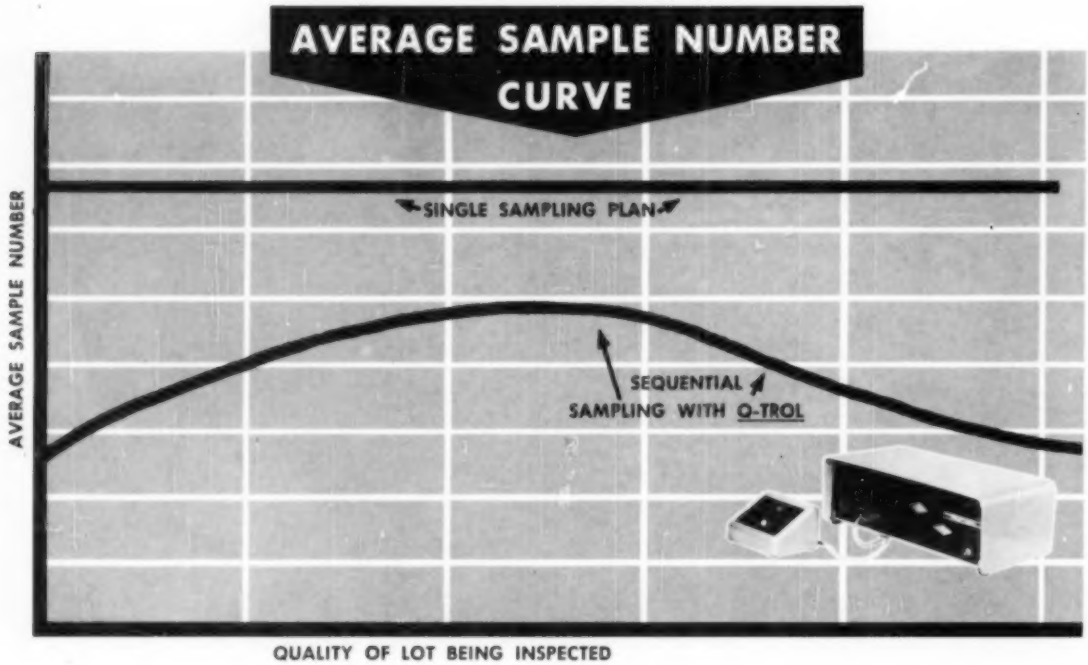

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Industrial Quality Control is published monthly by the American Society for Quality Control, Inc. Entered as second-class matter on Sept. 18, 1950. Second-class postage paid at the post office at Milwaukee, Wis., and at additional mailing offices.

Industrial Quality Control is sent to all members of the Society as one of the privileges of membership. Subscriptions from non-members are not accepted. Subscriptions for members only are $3.00 of the annual membership dues. Subscriptions for company, public, and university libraries are: 1 yr.—$9.00; 2 yrs.—$17.00; 3 yrs.—$25.00; 5 yrs.—$40.00. Back issues of Vols. I-X are available at $6.00 per volume including index: Vol. XI, $9.00; XII-XV, $10.00 ea. Individual copies are $1.00 each. Microfilm editions by volume are also available. The cost per volume is: I-VI, $8.75; Vol. VII, ff., $2.50 ea.

Orders for library subscriptions, back issues, and microfilm editions should be accompanied by remittance made payable to the American Society for Quality Control, Inc. *Orders under $5.00 must be accompanied by remittance.*

Industrial Quality Control is regularly indexed in the *APPLIED SCIENCE & TECHNOLOGY INDEX* published by The H. W. Wilson Company, 950 University Avenue, New York 52, N. Y.

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Notification of address change should be sent to the secretary of your section and to the Executive Secretary's office. Allow approximately seven weeks for the change to become effective.

Executive Secretary and Publications office: Rm. 6135 Plankinton Bldg., 161 West Wisconsin Avenue, Milwaukee 3, Wisconsin. Society's New York Address: Rm. 949B, 463 West St., New York 14, N.Y.

Address all correspondence to American Society for Quality Control, Inc., Rm. 6135 Plankinton Bldg., 161 West Wisconsin Avenue, Milwaukee 3, Wisconsin.

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INDUSTRIAL QUALITY CONTROL

Vol. XVII, No. 12 June, 1961

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From the President's Desk

GROWTH - Broader Horizons

I believe that you will be pleased to know that on March 31, 1961, your Society—ASQC—reached 12,950 members and shortly after topped 13,000. Service to others through the 16 short years of our existence, and much dedicated effort on the part of many hundreds of members and officers, has created this significant growth.

This growth has been accomplished in harmony with a rapidly changing industrial scene: more complex products—computers—automation, and drastically increased sales competition in the many countries in which our members work.

Throughout the world, careful quality control people intensify their assessment of science and product trends. The increased awareness of the individual and group responsibilities of quality control people which continues to develop is resulting in a rapid evolution in the types and capabilities of our quality control men and women.

This metamorphosis has created quality control people having an extremely wide range of capabilities in the fields of design and experimentation; ingenious in their use of chemistry, physics, and metallurgy, non-destructive inspection and testing, and, importantly, outstanding in personal integrity and community services.

More members and sections of ASQC are accomplishing leading and beneficial roles of service to the communities in which they live; and to the educational, industrial, and other product and service organizations that are becoming ever more thriving. I would like to mention only a few of these areas of service in which so many of our members are leaders:

Church and civic service clubs, YMCA's, *etc.*
School boards and education guidance work.
Local councils of Engineering Societies.
High school science fairs (promotion and guidance).
Development of training programs for industry and government.

At the National level, your Society has been very active in several broad areas. A few examples of national groups with which we cooperate are:

1. American Standards Association (Associate Member)
2. Engineers Joint Council
3. American Association for Advancement of Science
4. Council of Engineering Society Secretaries (Member)
5. Federation of Management Organizations (Member)
6. American Society for Engineering Education
7. Congress of Statistical Societies
8. American Society for Testing Materials
9. American Statistical Association

The success of all of these efforts has been paralleled by individual growth, and growth of ASQC! To each of you who have participated—congratulations! To those of you who are getting started—be energetic in a friendly and vigorous planned program for both individual *and* group growth.

This will cost us *nothing* save a little time and effort. And we stand *everything* to gain—both for our ASQC organization, and for ourselves as individuals.

Jay McClure

Management Development through QUALITY CONTROL

A. W. WORTHAM

Planning and Management Systems, Texas Instruments, Inc., Dallas, Tex.

A FEW SPECIFIC CORRECTIVE ACTIONS will, if pursued, make the decade of the 60's the most profitable and progressive of the quality control field.

During the past two decades, a comparatively large amount of material has been prepared and circulated through technical literature, symposia, conferences, etc., on various aspects of quality control. This information has concerned itself primarily with quality control technology, applications, and selling quality control programs.

To date, the progress of the field of quality control has been commendable. However, when the overall status of the field is reviewed, there are many deficiencies, inadequacies, and misdirections of talents.

What Quality Control Is Not

First, let us review some of the things which I am afraid many people think quality control is, but which I am sure it is not.

The items and discussions concerning them have occupied so much of the time and effort of people in the quality control field that it is no wonder that misconceptions have arisen in the eyes of our associates, and in some cases, our own colleagues.

If we review past actions and communications, we may be led to believe that *quality control is a selling job to management*. This is perhaps the gravest of misconceptions, since quality control is one of the strongest elements of management. It is not unusual to find in reviewing company or corporate objectives for a year, or even the charter of the business, to find explicit statements concerning the quality of product or services. How then can we have such a misconception? The answer to this, I believe, lies in a common mirror. Too many of us have not developed ourselves or our quality control knowledge, concepts, and abilities to the point necessary for acceptance. In brief, it is not quality control or management that we are selling, but ourselves, and we are not selling.

A second area of growing concern is the argumentative discussions on professional stature. This has grown out of proportion in recent years and many of our colleagues are becoming intolerant in the belief that we are possibly "status seekers." Obviously, we must achieve stature not by arguing among ourselves, but by earning it. This earning must come through achievement and proven accomplishment, not by *our* mutual consent.

Quality control is not the creation of quality control engineering job descriptions. Although the creation of job descriptions in any business or professional activity has substantial merit, it should not occupy an out-of-balance proportion of our time and should be undertaken by those professionally skilled in such matters.

Quality control is not a police action. I believe this is perhaps one of the greatest misconceptions to the point that it is even prevalent among many members of our organization. The quality control activity must not carry this connotation if it is to be successful. It is of extreme importance that we develop ourselves to the point of technological and managerial acceptance, rather than demand this acceptance through organizational activity.

Quality control is not a "cure all." Although there are many benefits to a quality control program,

ASQC LCS Code 300:10:000

Presented on the Rutgers' Conference program, September, 1960

and although it can submit rather dynamic accomplishments, it should still be recognized by all of us as one of the profit maximizing functions of our activity. In this direction, it must support the programs of engineering, manufacturing, and marketing and simultaneously must complement the other supporting programs of industrial engineering, control, purchasing, etc.

Quality control is not the belittling of the other functional elements of our business activity. I am afraid that too often the opportunity presents itself whereby we may find it easier to critize our colleagues in other departments than to face up to our own failures and inadequacies. This action never results in real progress but only adds to the difficulties of our future tasks.

Finally, and of great importance to recognize, is the fact that quality control as perceived by us may not be a necessity in our business. Many of our businesses have made substantial progress and have engaged in profitable enterprise long before the advent of quality control as we know it. This is not to say that a quality control program was not there. It definitely was, although in a primitive form, and it was adequate for the times.

Having reviewed some of the specific misconceptions which can and have easily developed in the quality control field, let us now turn to the positive side of the picture which is developing. Quality control, as any other field, is many things to many people. What it is to you will depend extensively on your own role and areas of interest.

What Quality Control Is

If you are a scientist, quality control is a growing dynamic technology. It is a young science full of frontiers and areas of new development. You can perhaps reach a research frontier in less time with less formal background in quality control than in any other technology today. Because of this, quality control research can offer more in terms of fruitful accomplishments than many of the older sciences and should be considered very seriously by the technologically inclined.

Quality control is a growing part of our management system. As the technology develops and as its value is proven by us or our competition, it becomes more and more an integral part of the overall system of management necessary to conduct our business.

Quality control is an insurance program. Particularly, if we are the purchaser of a product, for if we know the product has been manufactured in a quality control environment, we will have measurable confidence in its ability to meet our own specifications. If we are the manufacturer, it is also an insurance program, for we know that our products are being made in accordance with our economy and our customers' requirements.

Quality control is a profession, and in fact a multitude of professions ranging through inspection, technician, engineering, supervisor, research, development and management activities. The full breadth of quality control as a profession cannot be defined at this time due to the newness of the field, thus making it an even more fascinating area for our pursual.

Quality control is a management philosophy and objective. This was stated earlier, but is of such importance in concept and consequence that it must be repeated. As has happened, and as will continue to happen, quality control is a dynamic area of management and managerial development. Because of this, the young men entering the quality control field must be shown and must recognize this important aspect. If this point can be emphasized properly, we can all but eliminate the justification for the criticisms by management, redirect our views and opinions and achieve the desired success in less time.

Improperly treated, quality control as a sales gimmick is the worst kind of marketing promotion. It implies that only lip service is paid to quality control in the manufacturing organization. Promotional gains can be short-term at best and will be more than wiped out by difficulties and loss of sales.

Quality control is a cost reduction program. This is true only under specific circumstances and should be considered very carefully. The quality control program can increase as well as decrease cost depending on the objectives. It may sometimes happen that more expenditures in the quality control activity will decrease costs in some other area such as manufacturing, purchasing, and salvage. This cannot be guaranteed, and if the objective is to produce a better product we should normally expect it to cost more. In view of this, claims toward cost reduction should either be based on very careful economic analysis or after the fact.

Quality control is a way of life. This is perhaps the closest description to the overall profession. The number of people who have chosen this route and the diligence with which they pursue it is evidence enough. Each year the number grows larger and stronger.

This professional growth and development must not be left to chance. We must all initiate improvement programs for ourselves and our organization. In this direction, I would now like to state a few of the items which we must initiate, undertake or pursue to expedite the future of this profession.

Blueprint for the 60's

Work Together. We must work together in our sciences, and do everything possible to assure that all of us within a given activity are doing our utmost. We must be quick to grasp new applications and new techniques that are being tried by others in quality control and reliability activities, to try these methods in our own activity, and either further their utilization or help define their limitations.

Broaden Perspectives. We must broaden our perspectives. This includes our management perspectives in terms of developing personnel, and our technical perspective in terms of developing our techniques. We must develop our own management and technical techniques to best suit the function to which we are providing service.

Develop Opportunity. We must provide more opportunity for our younger engineers, both in terms of aiding the development of engineers within our sciences, and supplementing their abilities to qualify them for other capacities. That is, we should continually look for opportunity for our own younger assistants, not only in our own quality control and reliability fields, but also occasionally outside our own immediate activity.

Maintain Pride and Humility. We must have pride and yet humility in all of our quality control and reliability activities. That is, we must be proud of the job that we are doing, and must assure our-

selves that this job is a worthwhile and contributing part of our activity. At the same time, we must have humility and recognize that we cannot perform the task alone and may very often have to turn to others for assistance. This is particularly true since almost any problem in quality control or reliability work is quick to reach into other areas demanding the technical knowledge of other people within our organization.

Stimulate Others. We must stimulate others to assist us. This assistance should be both in terms of technological development in the fields of quality control and reliability and in terms of development in other fields which can contribute to our activity. That is, we should solicit many ideas that are available in other sciences, which can contribute substantially to our own development.

Recognize Others. We must exert all efforts to provide sufficient recognition to others. That is, we must be appreciative of the time and assistance given us. In this connection we may even, on occasions, give others the majority of credit for the work that we do. In so doing, we may make the next job easier and assure more cooperation and rapid advancement through better relations thus developed.

Lead in Character and Resourcefullness. We must lead in character and resourcefulness. We should be quick to spot new applications of the techniques that we know and be resourceful in getting others to try these techniques. We must be resourceful in stretching our budget and our people, but not to the extent of doing permanent damage by developing improper reputations.

Improve Salesmanship. We must develop further our ability to sell the quality control and reliability function and philosophy. This selling should be not only to our management and our fellow employees, but also to our customers and vendors. By developing the necessary salesmanship ability we will do much to further our own overall activities.

Employ New Techniques. We must learn and apply new techniques and new technologies. Only by doing this can we attain continued growth and stature.

Recognize Results. We must recognize both our failures and our successes. When a project has failed we must be quick to admit the failure. Similarly, we should be quick to respond to successful activities and ventures. By doing this, we will develop a better frame of appreciation of our fellow workers in other fields.

Attain Maximum Possible Progress. We must plan, make, and measure progress no matter how small or how large our particular quality assurance or reliability job. The most important phase is to plan what we will have to do in terms of progress. The second phase is to make sure that we undertake necessary steps to insure this progress. The final phase is to examine how well we measure up to our objectives. By continually taking these three steps, we will assure our development.

Strive for Efficiency. We must be efficient in our activities. The limited number of professional quality control and reliability people will not permit us to waste our time and efforts or to be inefficient in the utilization of our time. Because of this we must be overly conscientious about the efficiencies with which we operate.

Expend Hard Work and Long Hours. No one in any walk of life acquires success by doing only that which is required of him. We must, therefore, work long hours and apply considerable extra effort in our functions. This will have a two-fold effect. First, we will achieve much in direct effect through the application of these long hours. Second, and probably more important than this, is the fact that through the longer hours we will be indirectly benefited by the weeding out of those persons who are not professionally and psychologically qualified.

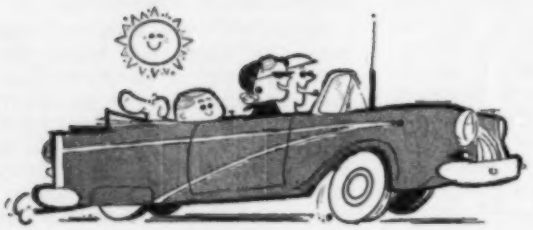
Provide Support to Technical Societies. We must support our technical societies. This not only includes ASQC, The American Statistical Association, the Institute of Mathematical Statistics, but also reaches into other technical societies such as IRE, The American Mathematical Association, etc. By showing support to more than our own area, we will interest others in what we are doing and become more familiar with their activities with which we are frequently concerned. Such association stimulates new thinking and new activity along with new technologies which we need from other areas.

Maintain Balance. We must maintain balance in our activity. This balance is one of the most difficult terms to explain comprehensively. Yet, if within our operation or organization we are too heavily endowed with engineers, our approach may be heavily slanted toward engineering and may miss some of the extreme benefits of, say, the statistical science. On the other hand, if we are too heavily endowed with statisticians, we may miss the benefits of the engineering or other mathematical sciences. Similarly, we can just as easily miss the benefit of good human relations and good business practices. This balance, although it cannot be easily defined, should be of primary concern and should be given extreme thought during the course of our activities.

The above list is perhaps incomplete and each of you could add your own specific requirements. I believe that it can serve as a nucleus for our guidance in management development. You will notice that in the main, the points are associated with management development and could be equally applied to almost any professional field. I am emphasizing them here because I believe we in quality control are so close to our own problems that we sometimes miss the tremendous advantage of the proper development to which we are exposed.

To clarify this point, a review of the exposure in industry of the quality control person is in order. A quality control man is in the position of learning more about the overall business activity than almost anyone else in the organization. He works with purchasing and the vendor in buying materials, with engineering and research in developing and designing the product. He gains an insight in the manufacturing of the product. He is associated with control and industrial engineering in costing and improving the product. He works with test equipment, design and product evaluation in assessing the product. He comes in contact with marketing and the customer in selling the product and understanding its use. In general, his job is related to all elements of the activity in addition to his activities in his own technology. It is for this reason that he must develop in a strong managerial capacity. He can be the catalyst or the bottleneck in building the business. It is not up to management — it is up to the man. Next time we are inclined to say, "If management would only . . .," let's look in the mirror.

QUALITY In The AUTOMOTIVE INDUSTRY



EDWARD G. BUDD, JR.

President and Director, The Budd Company

Mass Production, Quality, and Quality Control

QUALITY and QUALITY CONTROL are among the most important words in our industrial vocabulary. On every side we hear demands for better quality in our products. One hears that American quality has deteriorated — the quality of foreign goods is better — that American manufacturers are too concerned with mass production, and the consequent implied conclusion that mass produced articles are essentially less well-made.

These claims, and the implication that mass production is the evil of our times, can and should be challenged.

Mass production is the *marvel* of our age. Through volume we have been able to pass on to more and more individuals the benefits of the almost incredible advances in our scientific and technical knowledge.

Mass production has brought to the United States a standard of living for the majority of its people that is literally unbelievable to people in foreign lands. Our workmen are better paid, they work shorter hours and they live longer. Our people have more time for leisure and more time to spend with their families and friends; more time to enjoy cultural, educational and social activities; and if, as some people say, they don't use their leisure well, that is the educators fault, not the employers.

The continuous effort to make things cheaper and faster is not quite the whole story. We must add to these the never ending desire to make things *better*.

Take all of these together: cheaper, faster, and better, and we have the foundation on which our entire economic and industrial structure grows. These are the things which have made for material progress.

They have not caused a deterioration in quality. On the contrary, our levels of quality are higher than ever before.

However, there are some who will disagree with this statement so let us explore the premise in a little more detail.

When our products were simpler in design, manufacturing was also much simpler. Although the tools in use in former days were far more primitive than the precision

ASQC LCS Codes 100;300;352:80;70:434
Presented before Philadelphia Section, ASQC, May 1960

instruments in use today, they were equally suitable to meet the quality demands of the time. We had inspection in those days and defective pieces were pulled off the line. It was a rather simple matter to repair the defects and put the article to use.

Over the years, we have seen a tremendous improvement in our materials and the introduction of many new materials. Our designs have grown more complex and our engineering more exacting. Our manufacturing and production processes have been improved and quickened. New machines of tremendous capacity have been introduced, and we have developed mechanization and automation on our production lines.

And all of this has occurred while tolerances shrank to levels that would have been considered impossible just a few short years ago, and that in fact would be just as impossible now, were it not for mechanization, automation, and other improved methods.

For the most part, industry has manufactured component parts successfully to these new tolerances. Obviously, if they hadn't succeeded in this manner, none of the complex products would have worked at all, and our products do work well and last longer. Anyone who is inclined to disagree with the latter is invited to take a look at some of the automobiles of ten or more years that are still operating on our highways.

As the complexity of product increased, as the productivity per hour of output grew, and as the need in required hand-skills declined in mass manufacturing, fortunately the quality control concept grew. It offered a means of preventing the manufacture of inaccurate components; it offered a statistical sampling procedure that was inexpensive but very effective.

The application of scientific principles to the problems of measurement yielded results that showed we had to improve the new machines and set-ups, whose capacity to produce had out-run the capabilities of the old "inspection" concept. And so we learned to build more accurate machines and tools. The cumulative value of this revolution is really very great.

So the contention that quality has deteriorated just does not stand up to scrutiny. Quality levels have risen along with technical advances. Our problems today arise from the fact that even the new levels of quality are not adequate.

Changing Emphasis on Quality Control

We must have greater consistency and reliability in our products and parts of products. Broader development, and much wider application, of quality control principles will accomplish the goals. The present manufacturing processes make the repairing of parts or assemblies intolerably heavy in cost.

In some of our more sophisticated structures, this demand for fantastic levels of quality is almost unbelievable. There are some 300,000 parts in a long-range missile or space vehicle. One scientist estimates that even if 99.99 percent of reliability in the component parts is achieved, only three missiles in 100 will function properly.

A defect in an automobile is less spectacular in its manifestation than is one in a missile, but the same principles of exactitude are present. Despite the complex electrical systems — a present-day automobile has about 23 electrical circuits — the refined and higher powered motors, the automatic transmissions, the designs which call for the forming of metals into shapes we didn't believe possible, the many additional luxuries such as radios, clocks, cigarette lighters, and all the rest — every one of these items and assemblies must function properly or we have a dissatisfied customer and an expensive repair job.

So we turn to quality control for more refined methods and for more complete application of the techniques we now know.

It has been said "Quality walks on two legs" and I couldn't agree more. The human problems of quality fall into two categories.

First, as we progressively lift the burden of heavy manual labor from the backs of men, by improving machinery and by the use of handling devices, we create a much larger need for highly skilled tool and machinery designers, and for more and higher skilled men to build better machines and tools; and for more and better skilled people to maintain these more complex machines. We are transforming the skilled hand laborer into a much more skilled and sophisticated technician.

Secondly, we will need fewer, but much better trained people to operate these more complex, more expensive and more productive machines. We will have to have more intelligent, alert, conscientious and better trained people than their predecessors of a generation ago. The public school system, the universities, and the in-plant training programs will have to train this greatly increased skilled labor force.

We have to adopt in ourselves a philosophy of quality. We will have to teach this by example and by indoctrination, to our designers, our processers, tool and machine builders, and to the operators; and learn ourselves and teach our colleagues that poor and careless work jeopardizes our own future.

Foreign Competition and Quality

Now let's look at foreign competition and foreign quality. Let's face it, our foreign friends are pretty good and they are producing a high level of quality at low prices. American industry is up against the most serious challenge in history in the world markets. Our exports in many fields are shrinking and imports are increasing. We have not only priced ourselves out of some foreign markets but we are facing a serious invasion of our domestic markets.

Events since WW II offer an explanation of what has happened but they do not lessen the challenge.

Industry in Europe and Japan was almost totally destroyed and had to be reconstructed from the ground up. The United States helped with money, technical assistance and guidance. We gave freely of our know-how and sent some of our best brains to help them overcome initial difficulties and to start the rebuilding job.

Their accomplishments in a relatively short space of time have been astonishing. They have rebuilt entire nations and the scars of war have almost disappeared. And they have reconstructed their industrial facilities to a level far above pre-war years, and in some instances to a level above ours.

Most important of all, they have retained in their organizations a pride in quality. Everybody had to play a part in the reconstruction, and community spirit and enthusiasm reached new highs. As the new plants were completed and the new machinery installed — incidentally, the best that could

be acquired — each worker took personal pride in his work.

The Compact Car Story

The increasing imports of foreign cars of the past few years is an interesting story. At the beginning, there was perhaps a status-seeking cause for many Americans to buy imported automobiles. It was smart to own a foreign car. But that didn't last very long as the basic reason. More and more of our people saw the advantages of low cost transportation, and of smaller cars that were easier to park and handle in our traffic choked cities. The increasing number of two-car families also helped to swell the market for imports.

The foreign manufacturers did not create a new market in the United States; they found a ready market waiting for them, a lower-price market that had been more or less ignored by all but two of the domestic manufacturers.

The phenomenal success of the American Motors Rambler in 1957-58, at a time when nearly every other line was experiencing a drop in sales, unquestionably proved the point. The Studebaker Lark was equally successful when it went on the market several months later. The Ford Thunderbird also had a distinct rise in sales during this period and although this was not a low-priced car, it did show the desire of the customer for a smaller and a better automobile.

It didn't take the rest of the automotive industry long to see the new demands, and the introduction of the compact cars followed the next year. This is one of the healthiest moves the industry has made in many years. The customer has more models to choose from and a wider price range.

The success of the new compacts has been tremendous — some twenty-five percent of the total market to date, and the first specific move to meet the competition from abroad. The happenings of the past two years have brought a resurgence of vitality to the entire automotive industry. Never before has there been such intense and concentrated effort throughout an entire industry to improve the quality of product. The major manufacturers are spending large sums, not only to improve and extend the science of statistical quality control to all phases of production, purchasing and management, but right down through the entire organization to workers, to dealers and even to the customer.

An Example

Let us look briefly at one of these new programs that concerns just one model of the many produced by a large manufacturer.

First, they have set up a suppliers' management assurance control plan to control quality at the source. With this they expect to eliminate all receiving inspection at their assembly plants. They will ask for supplier management assurance that all material shipped is OK based on quality control charts. The plant manager, not the inspector, will be held responsible.

Second, they have put into effect at one assembly plant a trial operation to reduce the number of dealer-required inspection points to a minimum. At the start of the 1960 model, they accomplished a reduction from 72 to 10 items.

Third, they have set up an expensive program to teach quality to everyone from managers down to workers. This program includes the preparation of films, one for the officers and divisional managers, another for production supervision, and a similar program for engineers, sales and service personnel.

A program entitled "Attitude of People" will be presented to shop workers. Still another film will be devoted to sales and dealers, featuring their position in the community and the responsibility of their service department personnel.

The Budd Company

A few points about The Budd Company may be of interest.

This company was founded in 1912 as a part of the then infant automobile industry and we have been associated with it ever since, through good times and bad. Today, although we have a number of diversified interests, we still get 80 percent of our sales dollars from the automotive industry.

We have made a number of contributions to the improvement of the art of forming and joining metals. We were the first to develop the all-steel automobile body, the first to introduce the steel disc wheel to the American market and the first to advocate the frameless automobile body.

In 1930, we took our first step toward diversification, with the invention of the "shotweld" process and the development of the use of stainless steel for structural purposes. The shotweld was perhaps one of the first efforts to control spot welding accurately.

After experimenting in several fields with this high-strength, corrosion resistant metal, we concentrated on the railroad car industry and developed new structural designs to use stainless steel effectively to reduce weight with no loss of strength.

Most of the "name" trains of this country and Canada were built by Budd. Incidentally, the historic Pioneer Zephyr, the first of our lightweight, stainless steel, diesel-powered trains, is installed as a permanent exhibit at the Museum of Science and Industry in Chicago, after 26 years of service.

In 1939, we designed and tooled the first unitized automobile body to go into production in the United States. This was done for the Nash Rambler, later taken over by American Motors.

These things are mentioned because they grew out of our continuous desire to improve quality, methods and materials. From these efforts have come several of our current diversified activities.

Our Testing Laboratories were originally established to test and improve our own products and those we make for our customers. Today, this activity offers contract structural testing, static and fatigue, to a wide variety of industries.

Our interest in new and better methods of testing and measuring led to the establishment a few years ago of our Tatnall Measuring Systems Division and our Nuclear Systems Division, both now combined to form The Budd Instruments Division.

Closure

The American Society for Quality Control and its members, by developing and propagating the principles of quality control, is doing a great deal to help American industry meet the rigorous challenge of the newly re-established and re-equipped industrial nations of the world. It is helping to teach a fundamental truth — that it is cheaper to make a good article than a poor one.

LIFE TEST *some practical considerations*

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Abstract

The design of any worth-while specification must satisfy clearly defined and realistic objectives. The authors review current needs and specifications in the area of life testing components in the electronics industry, and propose a practical technique to satisfy changing requirements. The proposal is based on actual performance and has been shaped to make use of readily available techniques and equipment.

Introduction

Life testing is so universally required by today's specifications, particularly on components for military use, that it is commonly accepted as a way of life by the manufacturer and his engineers.

With the continually increasing emphasis on reliability of components and systems, reliability and quality assurance engineers are advocating new life tests, or extension of existing tests, with the fervent hope of attaining higher orders of reliability as a consequence of these new or more severe tests.

Practical consideration of the aims and means of performing tests at first may be overlooked.

It is the intent of this article to review the objectives of life tests in the hope of stimulating an informed and realistic review of current proposals.

Objectives

In view of the current stress on life testing, which gives every indication of being intensified in the future, it will be well to review briefly the objectives and general means of performing life tests in order to appraise more intelligently the various schemes now in use or being proposed. The basic aims of life testing and consequent costs are all too often neglected in the flurry of running tests and accumulating data.

The first step in designing or selecting a life-test plan is to review and clearly define the objective(s) of the test. While this would seem obvious, discussion of such items as sample sizes, failure rates, and methods of measurement have often become so spirited that the basic objective of the test is no longer dominant.

Life tests may be generally classified as having one or more of the following purposes:

1. Exploration of product characteristics
2. Lot-by-lot product acceptance
3. Qualification of a design and/or a process
4. Qualification of a manufacturer (skills and equipment)
5. Surveillance of (3) and (4) above on a continuing basis

Life tests may be required in order to complete the description of either an existing or a new product and so permit full engineering evaluation. Exploratory tests may seek to determine information about electrical, mechanical, or thermal characteristics of a component.

On the other hand, for an established product it is frequently necessary to determine whether a particular, discrete, lot meets specified standards of reliability.

Further, there may be a need to evaluate designs of a component, or the processes by which the components are produced, in order to see whether the designs and/or the processes are adequate for producing a reliable product.

Similarly, when a design or a process has been established as being capable of producing a reliable component, it is important to know whether a particular manufacturer is capable of effectively making the product in accordance with approved design and process specifications.

Finally, we may wish to know how a particular design or process performs over an extended period of time, or how stable the product from a particular manufacturer is in a long sequence of lots.

While a life test may have only a single objective, it is evident that in many situations it would be desirable to run tests for more than one reason. Accordingly, a given life-test plan may be designed so as to embrace two or more of the general objectives listed earlier.

Evaluation of Performance

After the basic objective of the test has been resolved and clearly defined, it is necessary to establish a method of evaluating the component or equipment under test. Some recognized methods are:

Functional test under in-use conditions
Simulated functional test un-under in-use conditions
Accelerated functional test under in-use conditions
Environmental profiles

Since actual performance in field equipment is the final criterion of performance of any component, life tests under actual use conditions would seem to be the most desirable method of evaluation. Yet, the wide variety of conditions to which identical types of equipments or systems may be subjected and the variations introduced by operating personnel make tests most difficult to handle. The problem of accurate data reporting is in itself a most formidable obstacle which has received extensive attention, but which is by no means solved. A recent ARINC report[1] states: "50 to 70 percent of tubes removed were unnecessary removals in the sense that the equipment would have continued to operate satisfactorily if they had not been removed.

Manufacturers of components, and in particular those of electron tubes, are painfully aware of the fallacies which may be introduced by taking field failure reports at face value, since often more than half of the components returned as "defective" are indeed found to comply with all specification requirements. This is usually due either to failure in equipment as a result of change in characteristic(s) which are still within component specifications, or to poor repeatability of some types of characteristic tests. Therefore field life tests must be handled with great caution, although this aspect of testing should be care-

ASQC LCS Code: 815:60:436

fully considered in conjunction with other types of tests.

Simulated Functional Test

Since the hazards of loosely coordinated field testing are so great, simulated functional tests are often used. A far greater degree of control can be exercised on such tests, because they are usually much more compact, and subject to close supervision of the testing agency. One problem here is to ensure that the simulated conditions do in fact represent field conditions, so that conclusions drawn from simulated tests may reasonably be extended to predict field performance. It is frequently impossible to extend to specialized and military applications the large-scale chassis testing which has become so common in the TV and radio components industry.

Accelerated Functional Tests

Because of the long duration of tests necessary on components with low failure rates, attempts are often made to accelerate the tests by increasing the severity of electrical, mechanical, or thermal test conditions. Here the hoped-for objective is to get failure information which can be correlated with field performance under more normal conditions. Such techniques have been successfully applied to the testing of resistors and capacitors, but have been inadequate for many other components and assemblies, including electron tubes.

Environmental Profiles

Specifications on many components now call for tests under a variety of conditions, where the environment is changed according to a predetermined pattern. This pattern usually involves programmed changes in physical environment and electrical conditions, over the domain of parameters to permit prediction of performance in a broad range of field conditions. This is particularly true of military and airborne items, which must be capable of withstanding extremes of temperature, pressure, and other environmental stresses not usually encountered by commercial equipments.

Environmental profile tests may be considered forms of simulated or accelerated tests and require all the caution in design and interpretation previously discussed in this connection.

Selection of Critical Parameters

The choice and unequivocal definition of the parameters to serve as the criteria of performance is most important. A clear definition of a parameter almost always requires that it contain a clear description of a valid test of that parameter. Unwieldy and unenforceable specifications have resulted from hasty attempts to catalogue all parameters suspected of being of interest in one or another of the long list of applications of many components. Fortunately, in many cases a careful choice of only a few parameters will serve as a reliable index of performance.

Pareto's established rule in economics has long been found to have a direct counterpart of wide applicability in engineering and industry. To paraphrase Juran's[2] statement of Pareto's rule: "In any series of failure causes, a small number of identifiable causes always accounts for a large fraction of the failures."

Thus, measurement of plate current, or of transconductance, or of the change in these parameters, will quite adequately describe the performance of electron tubes in most applications. In general, success depends on the selection of the fewest characteristics which will measure the behavior of the component.

In any case, there is little justification in adding end-points and tests to a specification unless such additions contribute a significant improvement to the test's total discrimination.

Choice of Time Interval

Duration of testing presents another nice problem in balance. If the test is conducted for too brief a time, it may not generate sufficient information, or may invite unwarranted extrapolation about performance over a longer period. This is especially true if the mode of failure changes during life. On the other hand, if the test is unnecessarily protracted, the delay in taking proper action, or in releasing the product, may be extremely costly. The choice of time interval between observations is a further consideration. If the *mode* of failure is important, the intervals must be sufficiently short to enable a valid estimate of the failure distribution.

Cost Factors

Considerations affecting costs of life testing should certainly include:

- Dollar costs of equipment and performance of tests
- Intangible costs in reputation, morale, engineering leadership, etc.
- Cost of information (or lack of it)
- Excessive complexity, lack of flexibility and adaptability
- Lost time

Life tests may be extremely expensive beyond the direct dollar costs of testing. Such costs may not be anticipated by manufacturers who have been stampeded into seeking reliability beyond the current state of the art. It is usually absurd to require for commercial applications the expenses that are justified only for equipment destined for use in outer space or in submarine cables.

An important consideration in the choice of life-test specifications is the availability of test equipment to gather the required data. Test equipment costs are not confined to, but do include design, rental, acquisition of life-test racks, test and read-out equipment, wages for operating and maintenance personnel, acquisition and operation of ancillary equipment (air conditioning, special monitoring equipment, etc.) Design and development costs may be especially important to environmental profiles and ultra-long life specifications. Such specifications may require not only the best components and equipment commercially available but incur additional costs in making a real advance beyond the current state of the art. The cost of developing specialized measuring and testing gear may exceed the cost of improving the product, unless improvements have wider applicability than the product under current investigation.

Intangibles include the reputation of the producer. If test facilities are inadequate, or if there is a record of failure to meet a life requirement, this may reflect unfavorably on the entire product line. Similarly, lack of sufficient information may prevent a producer from substantiating claims for a reliable product. Unanticipated high costs of an extensive test program may preclude a profit even on a product of demonstrated high reliability. Poorly chosen test intervals or duration, previously mentioned, may adversely affect all the other cost factors.

The life-test requirements, the available equipment, and operat-

ing personnel are inextricably interrelated. It is unrealistic to consider one without reference to the others. It is crucial to consider the cost in gain of information as well as in dollars in the listing of end points and characteristics to be monitored. Characteristics should not be added lightly to a specification in the mere hope that sooner or later mountains of data may suddenly turn into paydirt.

The choice of characteristics and time intervals have the greatest influence on complexity of administration and equipment.

A high degree of complexity inhibits flexibility in expanding a successful specification to the rest of the product line. Large sample sizes in general will make more automatic testing and equipment desirable, while an increase in a number of end points will be a deterrent to such progress. It is unlikely that any amount of automation or integration of test equipment with electronic data processing equipment will soon reduce the necessity for thoughtful simplification of procedures and specifications: if anything, current equipment and practice requires that automation be preceded by a greater degree of simplification and greater sophistication in design than most manual systems would have required.

Dynamics of Test Equipment

There is no static life test — all life tests are dynamic with respect to test conditions and environment, as well as time.

Some variations in test conditions and environment are carefully programmed into the testing routine, e.g., heater cycling, vibration and fatigue tests, temperature and humidity cycling, and thermal strain tests. Unintentional variations, however, frequently may be as large and as decisive to the performance of the component or equipment as the intentional variations. Poorly regulated electrical supplies may have a disastrous result on long-life performance, equipment may be unwittingly exposed to thermal shock (open window near temperature sensitive equipment), and rough handling may be more traumatic than either shock test or use environment. ARINC and similar investigations have shown the vital importance of correct installation of components under test, as well as careful maintenance and use of test equipment. A life-test schedule requiring frequent readings produces in some components mechanical and glass failures which never would have occurred under even the most severe in-use conditions.

A marked increase in sample size tends to down-grade the care and attention devoted to life-test sockets and terminals. Sockets and connectors which were designed to be used for only a small number of make-and-break connections are subjected to hundreds, or even thousands, of these cycles during life test. Reliable data requires careful routine calibration and maintenance of test and measurement equipment for life tests no less than for any other engineering activity.

Sampling

This subject has received much attention from theoreticians, statisticians, and engineers. Unfortunately, much of the attention lavished on life-test sampling is the result of frustration in attempts to state concise objectives of tests and inability to fix accurate costs. The consequence has been the design of sampling plans for general application without benefit of specific supporting data on the state of the art and progress attainable at a given cost. Such flight to theory unencumbered by fact results in computational procedures intended to squeeze the last dram of information from life test data, without regard to testing errors and natural variability inherent in present product and test equipment.

In applying any life-test plan, operating personnel must have a clear understanding where and how to draw the sample, when and how to test it, and how to report results. It is not enough to say "the sample shall be drawn in a random manner so as to represent the lot whose designation it bears." A sample drawn from a particular sequence of product at the end of assembly will not yield the same results as the same sample drawn from the same sequence of product after testing, or after aging or after packing, if for no other reason than that after each step the product is somewhat older. If the product has noticeable infant mortality, small delays in testing may have a marked effect on results.

Interpretation of Life-Test Results

The purpose of life tests is to furnish information for engineering judgment of the product or process under test. The objectives of such evaluation have been outlined earlier in this article. It is important to keep in mind that the statistical techniques and statistical considerations in design, sampling, and analysis are merely means to achieve the desired end, namely engineering evaluation. Under no circumstances should the end be subordinated to the means. This has been a temptation in other fields, as in indiscriminate use of control charts in production. Life tests in themselves, as control charts in themselves, are sterile and unproductive without mature evaluation of the intelligence they contain.

Information, interpretation, and evaluation are all merely steps toward feedback and action. A smooth flow can be facilitated by a realistic life-test specification.

Feedback

Life test is a time-consuming, slow process; therefore, it is all the more important to make foolproof arrangements for clear and concise transmission of significant results. Life-test results are of immediate importance to factory engineering, quality control, production control, and production departments. Significant changes in level or persistent trends are of concern to and may require participation by the sales department,

TABLE I—Log of Life Test Results on a Typical Miniature Tube Type (New Proposal)

LOT	SAMPLE SIZE	CUMULATIVE SAMPLE*	FAILURES	CUMULATIVE FAILURES*	UCL	LCL
1	100	100	1	1	—	—
2	100	200	1	2	5.5	—
3	60	260	1	3	6.5	—
4	60	320	0	3	7.5	0.5
5	40	260	0	2	6.5	—
6	40	200	2	3	5.5	—
7	40	180	0	2	4.5	—

*In Last 4 Samples

Confidence Limits = $M/N \pm 1.65\sqrt{M/N}$ where, M = Total Number in Last 4 Samples, and Allowable Failures = $1/N$ ($N = 75$ in this example)

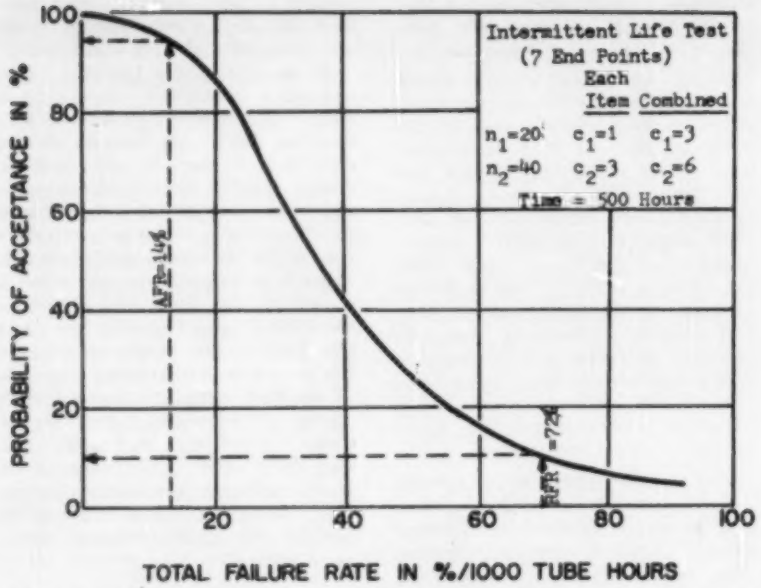

Figure 1—Approximate Operating Characteristic for a MIL-E-1 Intermittent Life Test with Seven End Points

research and development groups, and perhaps some officers in senior management.

The results of life tests and the implications of new specifications will increasingly involve members of the company who have never before been concerned with such esoteric activities. It is important that the initiated make a continuing serious effort to inform their colleagues and to keep them abreast of developments, without resort to unnecessary technical jargon or detail.

Representative Current Specifications

Routine life tests on production runs have become common only since World War II. Careful design, collection, and analysis of such data has come of age even more recently. Early specifications were hopefully intended to indicate the deterioration rate of components or equipment under test and to demonstrate that they would perform in service for "some reasonable time." For example, the pioneer JAN life-test specifications required only that a five-tube sample earn 80 percent of the credit hours attainable in 500 hours of testing under fairly conservative conditions. The low precision of such small sample predictors of lot performance was well matched by the limited ability to describe end-use conditions. This latter situation gave rise to the apt monicker "the universal unreliable component."

There was little point in drastic increases in expenditures for samples or testing until application requirements could be more clearly defined in respect to conditions, parameters, and duration. The first step in this was the identification and separation of product intended for entertainment end-use from that destined for airborne, military, and certain specialized industrial applications in which the dire consequences of failure justified a higher product cost.

The remainder of this article is concerned with this latter category.

The early MIL specifications are representative of efforts to write lot-by-lot product acceptance specifications to suit high-performance applications. This restriction made possible the design of a number of environmental tests (e.g., high temperature, humidity, and altitude tests). The duration of tests also grew: tubes were now left on life test for 1000 hours as a matter of routine.

These specifications were almost exclusively intended for lot-by-lot product acceptance, with only incidental surveillance of processes and manufacturers.

A recent approach to obtaining better reliability data on electron tubes has been advanced by an *ad hoc* committee under the auspices of The Office of the Assistant Secretary of Defense for Supply and Logistics (OASD).[3] This committee considered several plateaus of reliability, Level I being the level attainable in the current state of the art. Subsequent levels were to carry well beyond capabilities attainable in the immediate future.

The OASD proposal for tubes contemplates a new high-reliability life-test sample for Level I of n=80, with acceptance number c=2, and a test duration of 1,000 hours. The number of end points has been reduced to facilitate handling of the comparatively large sample size, and to enable direct

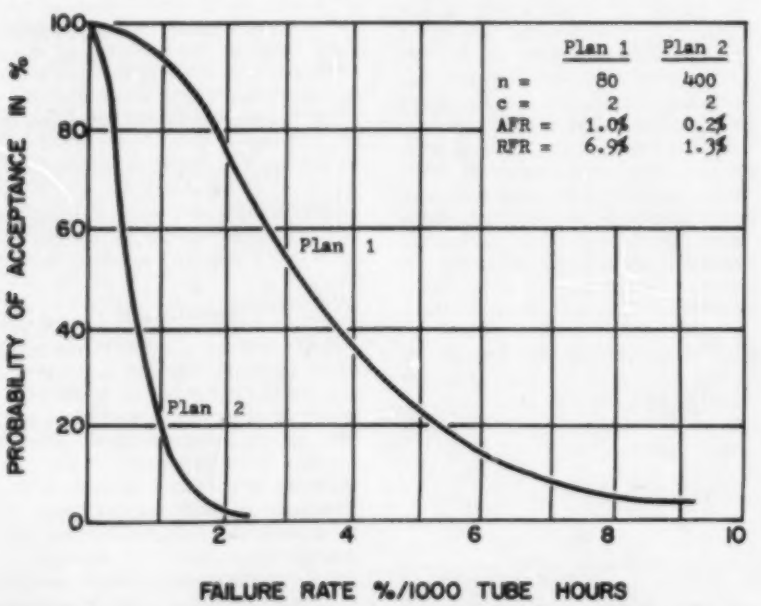

Figure 2—OASD High Reliability Life-Test Operating Characteristic Curves

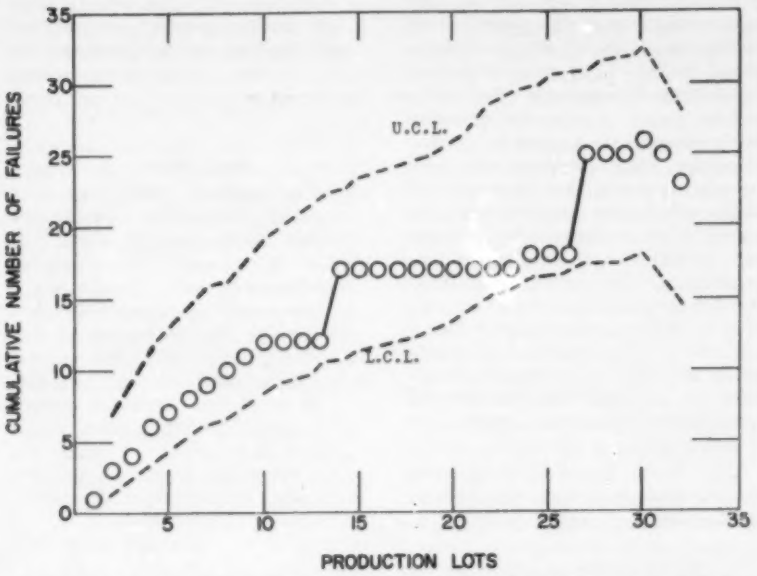

Figure 3—Typical Chart of Cumulative Defectives (MIL-C-26244 Capacitor Specification)

reading without removing the tubes from the rack (see Fig. 2).

The first marked deviation from lot-by-lot product acceptance is contained in the USAF Capacitor specification of January, 1958 (MIL-C-26244).

This document has several objectives:

- Lot acceptance
- Qualification of the design and process
- Continuing surveillance of a manufacturer
- Encouragement of the manufacturer to continue to reduce the failure rate of the product

The sampling rate, as well as the sample size required for each production lot, depends on the total quantity contained in all production lots submitted during the preceding 30 production days. For very small production quantities the sampling rate is 30 percent of any one production lot; this sampling rate drops gradually with increasing production quantities, leveling off at five percent of any production lot from a large run.

This specification provides for the rejection of individual lots whose life-test sample have excessive failures, and renegotiation of the contract if there is evidence of long-term deviation from the nominal acceptable failure rate. (see Fig. 3)

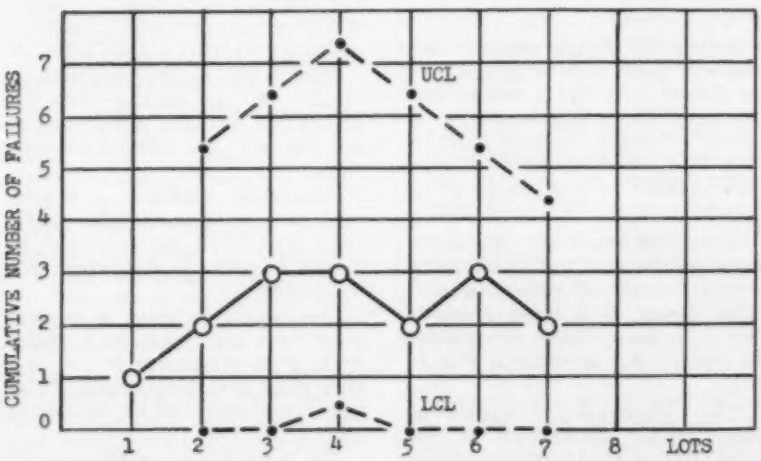

Figure 4—Chart of Cumulative Failures (Last Four Lots) on a Miniature Tube Life-Test Series

It is evident that evaluation of a continuing series of life tests, as recorded on the production log and the cumulative plot, affords a means of rating the manufacturer, and performing continuing surveillance on his product and facility.

Multiple Objectives Require a Flexible Plan

The demand for higher reliability continues to intensify; it is becoming increasingly apparent that no single set of checks is adequate to give sufficient quality assurance: the design, the processes, the subassemblies, the manufacturer, and the end product are all susceptible to evaluation, and modern needs compel us to base conclusions on the sum of *all* available information.

An important part of the proposal is a continuing log of test results and a plot of the total number of failures in the last four samples. The following plan was developed to meet the needs for high reliability tubes of the Air Force and to be consistent with current desires of DOD (Table I, Fig. 4).

Sample sizes depend only on the degree to which current life test data is consistent with the specified Acceptable Failure Rate (AFR). If the observed rate is significantly higher than the AFR, the sample size increases to a preset maximum; failures in excess of the limit on failures in a single sample result in lot rejection. Continued results in the neighborhood of the AFR permits successive reductions in sample size until a preset minimum is achieved. An average sample failure rate significantly below the AFR is a qualification for renegotiation of the contract.

This plan differs from both the OASD and USAF proposals in that the sampling rate is entirely independent of production quantities, and puts a constant bound on the confidence level associated with the current estimate of the failure rate.

Further the proposal is not limited to any arbitrarily chosen failure distribution. Failure rates and testing schedules may be based on the Normal, Weibull, or exponential distributions without making any changes in routine instructions.

This plan has been designed to

achieve the following objectives:

- Generation of reliability data in a routine and orderly manner, subjected to regular engineering review
- Evaluation of a particular manufacturer of a given design
- Surveillance of product, as well as lot-by-lot acceptance
- Constant incentive for the manufacturer to strive for quality improvement
- Adaptability to meet changing reliability requirements without major redesign of the plan

This plan may be easily adjusted to meet the demands of a variety of situations. For example, if history over a number of lots demonstrates that the product can easily meet the initially established failure rate, it is a simple matter to renegotiate the AFR and/or price. Again, to increase the precision of samples or to accumulate data more rapidly, the sample sizes may be increased or additional larger samples may be tested. If it is desired to increase the pressure for reliability improvement, the confidence level and/or sample size may be adjusted. When a cumulative sample over a larger segment of product is needed it is a simple procedure to increase the number of consecutive lots over which the sampled data is summed.

This basic framework for life testing and reporting results has the flexibility to meet a wide range of requirements, and brings with it the advantages of standardization: consistency in performance and administration, simplified training, evaluation, and comparison.

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BUILD A QUALITY TEAM

RALPH VON OSINSKI, *Chicago Rawhide Manufacturing Co., Chicago, Ill.*

Only a quality team can produce the quality products demanded by today's consumer.

Let us look at this team.

Who is it?

How is it built?

What does it do?

Who Is It?

To answer the first question, let us look at the people involved. A quality team is composed of the people in sales, engineering, purchasing, manufacturing and quality control.

The *Sales Department*, being in direct contact with the customer, is in the best position to interpret the needs of the customer. Customer correspondence, vendor rating reports, reports on field trips and explanations of how a part is used, can be of great value to manufacturing personnel.

Quality control is the best source to feed this information back to the employees. Information about returned goods, although it should not be the direct basis for establishing customer quality standards, can be used to prevent the recurrence of shipping defective material.

The sales department plays a very important role on the quality team.

The *Engineering Department* must work closely with quality control in establishing tolerances and specifications that are realistic.

Before the design engineer releases a pilot run to production, he should ask "Did I design this product with optimum quality in mind?" The quality team must be sure that all characteristics have been studied so they can be properly controlled.

It is important for the company and the customer to know the cost of quality. Engineering must plan, design, and build products that give the customer the quality he desires at a price he is able to pay.

The *Purchasing Department* plays an important part on the quality team by supplying manufacturing with the quality components necessary to obtain the desired finished product.

In order to do this, it must know how well the vendors are doing. Part of the quality control function is to supply this information to the purchasing department.

A vendor rating system of simple design is a good starting point. This enables the Purchasing Department to select vendors capable of delivering the type of material necessary to build a good product.

Manufacturing has a big responsibility on the quality team by proper job training, knowledge of the product, and good workmanship.

Production planning and production control must allow sufficient time for a job to be run so it may be properly inspected prior to shipment.

The people building a product must have good material to work with, good equipment to use, and they must be making products that have been designed to do a good job.

The manufacturing department, because it is the one which builds

ASQC LCS Code 000:70:400

the product, is the one that needs special consideration in building a quality team.

How Is It Built?

The quality control engineer is a key man in building the quality team. He must have a background of statistics, engineering, chemistry, physics, and many other things.

In addition, he must work well with other groups, collect data in an orderly fashion, analyze it, and interpret his findings in such a manner that they can be understood.

In many cases he is comparable to a doctor, working to diagnose and prescribe for a healthy quality cost balance within the company.

Build With Statistics

Recently an insurance man told me he would gamble that I would live to be 65 years of age. He is taking a well calculated risk.

The quality control engineer uses the same kind of calculated risk in the control of quality. He can decide on the acceptability of a given lot by the number of defectives observed in a sample. He can also sample material from a manufacturing process and calculate the capability of the process, or, he can analyze given variables and determine which one has the most effect on the process.

These are some of the applications of statistics to the control of quality. This type of information, with the proper feedback system, helps the other members of the team perform their job more efficiently.

Build With An Inspection System!

How strong should the inspection system be?

As it is difficult for a man to judge himself, it is also difficult for a worker to judge his own quality. Part of the quality control system is to have trained personnel to determine what is good or bad quality.

Today's mass production methods have forced men to become experts, each in his own field. As we go to the doctor to diagnose our ills, we go to quality control to determine quality.

Quality control should gather information from the other members of the team and make the final decision. But when it makes a decision, it had better be right!

Many progressive companies have developed "inspection route sheets." These give a complete breakdown of what to inspect, how to inspect, and to what quality levels to inspect.

With the use of the "Route Sheet," anyone capable of performing the functions is able to make the decision to accept or reject. Specific characteristics that may have been overlooked in the original design and result in customer rejections can be added to these sheets to prevent future occurrences.

Records or Red Tape?

The proper feedback system is important in any functioning organization.

Scrap records and reports are not only essential to production control, but also show the quality control engineer where to aim his attack. Good "in process" records are a valuable source of information, but records must contain pertinent information and be easily kept.

Do not keep records just for the sake of doing something. Collect data that is of value to the team.

Build Through Training:

Customer orientation is an integral part of the quality team. People who *know* what they are doing are much more *interested* in what they are doing.

We should never be so busy with our finger in the dyke that we can't stop to see if there is actually any water on the other side. Mr. Factory Employee likes to know what is going on. He must be trained carefully with regard to quality. He must be trained in uniformity of quality, so quality levels remain constant. He should be trained in basic quality control so he knows there is such a thing as variation and that it can occur in an orderly manner.

We do not wish to make him a statistician. We only wish to show him how to assure good quality through statistical methods.

When he understands the quality control concept, he will be a much better member of the quality team.

What Does It Do?

A well informed quality team can meet any challenge presented to it.

The team moves in unison to meet the quality goals set by modern day advertising. Mr. Consumer is very conscious of quality when he makes a purchase. If he doesn't like it, he doesn't buy.

A well organized quality team can reduce scrap costs, identify areas of process improvement, and meet price competition.

A well organized quality team can meet the challenge of maintaining a profitable balance between the factors of quality and the factors of cost, and this *is* its primary purpose.

RIT to Conduct Program For Graphic Industries

Presentation of the 4th annual RIT-SQC Award to an outstanding industry leader will conclude the 11th annual program of Quality Control for the Graphic Industries which will be sponsored by Rochester Institute of Technology June 26-30 at Rochester's Towne House Motor Inn.

Previous winners of the award have been: B. E. Sooy, S. Curtis and Son; Donald Macaulay, president, Paper and Printing Quality Control, Inc.; and Dr. Carl Noble, director, Consumer Acceptance Dept., Kimberly-Clark Corp.

Course content for the seminar will include: Who Uses Quality Control, Basic Quality Control Methods, How to Establish Inspection Systems, How to Use Control Charts, Roundtable Discussion of Methods and Techniques for Improving Efficiency and Quality, How to Use Quality Control Information, Special Problems Seminar, Laboratory Session, and Organizing Quality Control Programs.

For detailed information on the course, contact Harold M. Kentner, Director, Extended Services Division, Rochester Institute of Technology, Rochester 8, N.Y. Course fee is $250.

Modern Inspection AND AUTOMATION Techniques

EDWARD A. REYNOLDS *Quality Consultant, Ligonier, Pa.*

Purpose of Inspection & Quality Control

REGARDLESS of methods, all inspection is intended to insure specification compliance. Originally, and still in many instances, the method was to locate and remove defects.

In recent years much greater emphasis has been placed on prevention of defects by identification of trends or tendencies to produce bad product.

This emphasis, as well as development of modern concepts of reliability and statistical techniques; improved sensing and measuring devices using electronics, sonics, and nucleonics; and data computation and feed-back systems, have all contributed to important changes in the methods of inspection.

Despite development of these methods and changes in emphasis, the basic purpose of enforcing specification compliance — with the required assurance and at minimum overall cost — remains unchanged. Whether the inspection engineer is considering an air gage in place of a micrometer or an automated process control system, he should ask himself:

> "Is this the method which will give the *required assurance* of meeting specifications *at the lowest total cost?*"

Progress in Inspection & Quality Control

In the history of manufacturing, there have been five rather distinct advances in inspection and control methods in the past 150 years. The inspection supervisor who is unfamiliar with some of these may find further study of interest or value. Briefly, they are:

Individual Craftsman — with product quality dependent almost entirely upon his personal skills and interest. We still have many industrial jobs requiring highly developed manual skills, but their number decreases each year. As far as mental skills and interests are concerned, these continue to grow and the need for growth expands at even a greater rate.

Each of the following inspection and control advances requires great skill and interest on the part of today's "craftsmen" — the designers, chief inspectors, statisticians, engineers — as well as the skilled mechanics and technicians who operate the equipment and systems.

Product Sorting by Inspectors— the first industrial method attempting impartially and skillfully to enforce uniform standards of quality on a group of production operations and operators. Although having many obvious disadvantages, the basic ideas of definite specifications (even though only in the mind of the inspector), of special tools for inspection, and of the inspection operation as one requiring special skills, are all important in this as well as later steps.

Statistical Process Control — aimed at uniform maintenance of the most economic level of quality through a planned system of defect prevention. Some of us believe that in the future the process control and material acceptance methods of SQC may be largely replaced by automatic controls and automatic 100 percent testing. However, there is no doubt that SQC methods will for many years help make things better, cheaper, quicker. In addition, its philosophy, "planned control based on data, not opinion," will remain with us always.

Automatic Inspection and Testing — A major factor leading to the use of statistical sampling was the requirement for reliability of product which could not be 100 percent inspected. This was due to the destructive nature of the test, to large quantities, or to human errors in sorting inspections. As product tolerances have tightened, in some cases beyond process capabilities, and as reliability requirements especially in military equipment have also increased, it became necessary to 100 percent inspect many items. Developments in the past 15 years in automatic gages, spectroscopy, radiography, ultrasonics, eddy current tests, radioactive or fluoroscopic tracers, etc., have made 100 percent testing practical and more useful than sampling in many areas. Today, the inspection engineer often has a choice between sampling and high-speed 100 percent inspection which was not available to him only a few years ago. In many such cases, he is reverting to 100 percent inspection — automatically, or semi-automatically — because of higher reliabilities or lower costs.

Automatic Process Control — The same reasons of high-speed production, critical and difficult tolerances and tightened reliability requirements which led to the use of statistical process control are today, in some instances, leading to automated testing, data analysis, feedback and adjustment of the production process to prevent defects. This has been true for some time in chemical operations and is now also being applied to mechanical and metallurgical processes.

CERTAINLY ALL of the above methods — and in improved forms — are required in most plants at least to some degree, but the emphasis is surely moving toward further automation. The chief inspector of 1940 who had to learn statistics to be the quality manager of 1950, and in 1960 is learning advanced use of ultrasonics or spectroscopy, must before 1970 know much of instrumentation and of computers.

Relationship Between Modern Inspection and Statistical Quality Control

The old-time chief inspector has been pictured as a perfectionist; usually skilled in process and product, but without broad education; and normally with little

ASQC LCS Codes 710;720;740:60;70:400
Presented at the ASQC Conference, Rutgers • The State University, New Brunswick, N.J., September, 1960.

concern and less knowledge of company costs.

Today's capable inspection supervisor or engineer is quite different. He should know the value and need of definite and logical specifications, understand AQL's and reliability, and use statistical principles to decide when to accept or reject, when to take action, and when to be satisfied regarding a new product or a new inspector. All of these he can learn from SQC.

However, he also must have other new knowledges and skills. They may be in dimensional inspection by optics, in determining proper lighting for visual inspection, in personnel methods for training technicians, or in laboratory testing, record systems, nondestructive testing, etc.

Today's inspection head and his key assistants must have skills in three areas — administration, engineering and statistics. One alone is seldom enough.

The basic methods for good administration of inspection are fairly similar in many types of industry. The engineering methods will vary widely, though much from one industry may be of unsuspected value in another quite different field. The statistical principles are, of course, common to all though specific methods do vary with complexity and size of operations. The fact that — rightly or wrongly — the engineering methods of inspection and test are considered separated by industry has reduced the available training in these methods for many quality or inspection heads. Nevertheless, they are at least equal in importance to the statistical and administrative knowledges.

The quality control man who ignores recent engineering advances in inspection is as near-sighted as the chief inspector who ignores statistical methods. It is unfortunate that to date there has been so little combination of statistics and automated inspection. For example, the SNT new (1959) *Handbook of Nondestructive Testing* still talks of "Percentage Sampling" and contains, to my knowledge, not a single reference to any modern statistical technique. Likewise, the ASQC journal *Industrial Quality Control*, again to my knowledge, has included no articles on modern methods of 100 percent inspection or test.

There is a most useful field for the inspection or quality head who understands both the statistical and the engineering aspects of controlling quality and who can apply both. Especially do we need statistical evaluations of the accuracy and precision of our radiographic interpretations and techniques, of the standardization of our ultrasonic instruments, of the reliability of zyglo and of process instrumentation — just as in the past we have usefully applied these techniques to evaluate and improve our micrometer and visual inspection results.

PERHAPS a combined committee from ASQC, ASTM, ISA and SNT would be helpful to promote broader understanding of the interrelated methods for control of quality.

In the meantime, inspection and SQC methods are not in conflict. At worst, each has its place in modern quality control. At best, they can be very useful partners.

Developments in Inspection Techniques

Inspection operations can, rather broadly and loosely, be divided into at least the following categories:

Dimension inspection

Visual inspection for defects or correctness of production operations

Visual inspection for color, texture or pattern

Flaw inspection for defects not normally visible

Physical inspection for hardness, weight, strength, etc.

Analysis inspection for chemistry, fineness, grain size, etc.

Performance inspection for operation, noise, leaks, current, etc.

Odor or taste inspection

Recognize that there may be much overlapping. An inspection for surface finish might be called dimensional, visual, physical or analysis.*

However, the above may at least illustrate the broad scope of what we call "inspection."

There have been—and continue to be — major improvements in all of the above types of inspections, as follows:

Specification improvements — The trend toward more definite and logical standards, which are enforceable in production and meaningful to the customer, has done much to encourage inspection methods improvement — as well as making such improvement essential.

Industrial engineering improvements—Better selection and training of inspection personnel, work simplification studies, better layout and lighting, etc. have all been beneficial.

Evaluation of inspection accuracy — Scientific evaluations, often by statistical methods, have both caused and permitted many improvements as information was made known on inspection error and the portion or error due to personnel, method, etc.

Improvements in existing methods — There have been innumerable improvements in older inspection methods and equipment — all the way from new micrometers that reduce the effect of inspector feel to finer grain X-ray films. Many of these have improved accuracy; some have made the inspection suitable to entirely new products.

New inspection techniques — In this area are, no doubt, the most interesting improvements — so exciting that we often forget the importance of the less spectacular developments of advances listed above.

Many of the new techniques have use in several types of inspection. Eddy current inspection, for example, is best known for detection of hidden flaws but may also be useful for dimensional inspection, for analysis inspection to detect changes in chemistry, or for physical inspection to locate hardness differences, etc.

In addition, a number of the new methods have spread to other industries, different from the ones for which they were originally developed.

Inspection Techniques Aiding Automation

It is far beyond the scope of this article to discuss in any detail the many new developments in automatic inspection and automated process control. However, following are a few comments on some of special interest.

Dimensional Air Gaging

Although used for many years to check precision dimensions, their use today seems well adapted, in many instances, to sort parts automatically or to provide infor-

The purist may say that many of these are really "tests" and, actually, they all may be. The use of a micrometer or comparison with some visual standard is actually a "test." If we are to distinguish between "inspection" and "test," it would seem logical to use the former to denote 100 percent examination and the latter for quality determination on a sample. Thus we might "inspect each lot by testing one piece per lot."

mation for automatic process control. Other type pneumatic gages may check width of moving sheets, and thus control slitting or winding operations.

In the future, there may also be useful applications of air gaging on non-metallic parts and processes, or for automated measurements of surface finish, etc.

Electronic Gages

Many automated inspection operations require non-contact with the item being checked. This can be accomplished with certain types of electronic gages, incorporating pneumatic or nuclear gaging.

In some cases the ability of an electronic gage contact to move automatically until it is within some precise distance of the part offers possibilities for very precise checking of parts over a wide size range.

Electronic, non-contact measurements of temperature (often by infra-red) also offer many new control possibilities.

Radiography

The wide use of radioactive isotopes, due to low cost and versatility, as well as improvements in X-ray equipment (xeroradiography is a good example), have broadened applications for defect prevention. Also, nuclear or X-ray thickness control are common on steel rolling mills, rubber calenders, cigarette forming machines, etc.

Additional applications seem certain for automated control of dimension or density of extrusion or other forming operations, or for control of solid content of slurrys, etc.

In addition, the advances in *fluoroscopy*, often with TV or other intensification systems, combined with mechanical improvements in remote handling equipment, may prove very useful in inspections of forgings, castings, molded plastics, etc.

The future combination of these methods with automatic scanning and interpretation may make automatic control possible for location of internal defects, permit exact automated cropping of pipe ends, etc.

Further advances in X-ray fluorescence and perhaps in X-ray diffraction methods and equipment may also offer improved and increased use for routine inspection and control. (X-ray fluorescence is, of course, now being used for routine chemical analyses in many instances.)

Ultrasonic Inspections

Originally designed for flaw detection in metals, the principles of ultrasonic transmission or reflection are now widely used for dimensional checking and for automatic or semi-automatic inspections and controls on plastic, rubber and other materials. The further development of ingenious devices for providing sonic input to moving items, hot materials, and complex shapes will certainly spread the use of these principles.

Eddy Current Tests

Here also is a technique originally designed for automatic detection of internal, or invisible, flaws in metal fabrications. It shows great possibilities for dimensional checking as well as detection of change in composition or analysis.

It may be that eddy current inspection can even be usefully applied to some non-metallic materials.

Spectroscopy

Spectroscopic inspection of metals has largely replaced wet chemistry as routine method of control in many industries. To date, these have not been as widely applied for control of analysis of non-metallic compounds, but many developments indicate expanded use in the near future.

Whether we shall soon see automatic controls of processes based on continuous automated spectrographic analysis is questionable, but seems a possibility.

Mass spectrographic leak detectors have been in use for many years on automatic or semi-automatic inspection of items ranging from cigarette lighters to automobile brake cylinders. These also offer good promise for automated process controls. (There are also other leak detectors which may be equally suitable, at perhaps lower costs.)

Optical Measurements

Precision dimensional measurements have been made for many years with optical projection comparators and with optical scope devices. Equipments and techniques have been much improved in recent years from the old "shadowgraph" and transit. Coupled with photocell or electronic scanning for interpretation, these may offer possibilities for automatic inspection or control of dimensional or visual characteristics.

In addition, the use of special inspection equipment to check visual imperfections — either by use of TV magnification or by color movie film — is practical now for difficult (or impossible) to see locations. Again, this may offer future automation possibilities to monitor appearance requirements inside pieces of equipment during processing.

THE ABOVE are only a few of the interesting developments or possibilities for the near future. In addition, it seems certain that the next few years will bring entirely new methods, as unthought of today as many of the above were only a few years ago.

Sources of Knowledge and Training

To keep abreast of new techniques in inspection and control is a major part of every quality manager's or chief inspector's responsibility. Each year this becomes more difficult, as methods advance in both numbers and in complexity. Each year, too, this becomes more necessary. There is no easy short-cut to knowledge, or a possibility of progress in our field without advance in technical knowledge.

It is my belief that the progressive company should budget at least five percent of its technical employee's time for advancement training. This average of two hours per week, or two weeks per year, is about the minimum required for any level of engineer or technical supervisor to keep up with some of the technical improvements in his field. To this the ambitious technician or the manager who wishes to at least retain his present stature must contribute an additional two to six hours per week of his personal time for such study.

There has been much public discussion in recent years of the need to improve our elementary education and to turn out more and better college graduates, if we are to compete successfully against totalitarian methods. Certainly better beginning education is required but advanced training of our inspectors, chemists, engineers and managers is equally so. Unless some appreciable portion of our technically trained men are willing, even eager, to work for scientific improvement, we shall surely lose to those whose greater interests will result in greater skills.

In this connection, a typical recruitment advertisement in the

New York Times states that engineers at . . . company "are learning the fun of fishing, water skiing, boating — they cook out more, play more golf than ever before."

I cannot help comparing this with another famous recruitment ad of years ago when Sir Ernest Shackelton placed a small ad in another *Times* — "Men wanted for hazardous journey, small wages, bitter cold, long months of complete darkness, constant danger, safe return doubtful. Honor and recognition in case of success."

Sir Shackelton was reported swamped with applicants. I am pleased to doubt the response to the ad for missile engineers was as successful.

For the interested inspection engineer, quality manager or technician, who is either willing to endure some hardship in return for "recognition in case of success," or who enjoys learning new techniques in his chosen field, there are numerous methods of keeping current and increasing his knowledge.

THERE ARE at least four technical societies concerned with quality control. All overlap to some degree, but each specializes in one area or group of techniques:

American Society for Testing Materials (methods of test)
American Society for Quality Control (statistical control)
Instrument Society of America (automatic process control)
Society for Nondestructive Testing (sonics, radiography, etc.)

In addition to technical societies and their training seminars and publications, there are many excellent texts on varied aspects of instrumentation, inspection, tests, automation, etc.; also a few college courses in some of these subjects. However, many of the best training courses are offered by equipment manufacturers in such subjects as optical inspections, nondestructive testing, computer applications, etc.

Some recognized universities also offer good correspondence courses, at undergraduate or graduate level, in some of these and related industrial and technical subjects.

Importance of Industrial Advance

The industrial revolution began early in the nineteenth century. It was sparked by Watt's development of steam power and Whitney's concept of planned mass production — with its system of separate operations, specifications and gages. As we all know, this was not an immediate change, but a fairly gradual one — though abrupt enough to cause broad unemployment in some areas, increased prosperity in others.

Even today, and even in our United States, there are many jobs still done by brawn — many companies without engineered operations, definite standards, adequate tools or gages. However, each year their number becomes less through a combination of change for the progressive and of attrition for the ill-prepared.

At the risk of repeating well-known history, it might be worth reviewing the importance of this first industrial revolution on the American way of life. That our country was the first to develop and largely apply these principles of mass production, precise specifications, interchangeability, gaging and machine tooling, for the ever cheaper production of ever better products, is the *sole* material reason for our standard of living and our national might.

Certainly we would never have achieved these as a community of agricultural states, and there are many countries with more manpower, larger areas and greater natural resources than our country.

Contrary to much popular opinion, neither have we had a monopoly on science. Most of the major discoveries in mathematics, astronomy, physics, medicine and biology have been made by the large majority of the world's population living outside the United States.

Even our most remarkable and awesome development of the century, the atom bomb, was done for us largely under the direction of an Italian, working on theory from a Dane, after the idea had been explained to our president by a German!

More recently, the progress toward command of space has demonstrated that scientific leadership is not our private national commodity.

AND SO IT SEEMS that, aside from our advantage of free and democratic government, the ideals of personal equality, individual liberty and capitalistic initiative, America has profited most from application of production techniques to improve reliability and reduce costs of the items the world needs and wants.

In this we still lead the world, but each year our lead grows smaller. We do not need the statistics of world industrial output to tell us this, although they do so very convincingly. All that is necessary is to look at the comparable quality and prices of imported steels and shirts, or optical instruments, watches, lathes, tennis balls and sailing boats. Even in America's main industrial pride, the automotive industry, imports grow each year in volume and, many think, also in comparable quality.

In the past, most foreign manufacture was either of vastly inferior quality, or consisted of handmade luxury items too costly for any but the very few. Today, neither is true and many foreign companies are competing with success in the mass production market. This in itself is not deplorable, but rather commendable as a measure of industrial growth among our neighbors. However, we have lost much of our industrial leadership as others have caught up to our technology. As Russia increases her industrial exports and as new powers like Australia, China and India become industrialized, this competition will increase many-fold.

There are some who believe the answer is to increase our tariff barriers, or to subsidize our inefficient industries by further taxation of the prosperous. Others suggest the pay scale of American works is too high or their efficiency too low.

In certain instances, changes in any of these areas may be required, but, basically, I believe the answer is that we *must* continue to lead and to educate the world in ever improved production methods. Thus, we shall both help America and also constantly aid other nations to raise their own standards of life.

The world market is crying for clothes, for foods, for medicines — and also for the luxuries that separate human life from a routine struggle for existence. We must encourage foreign industries so that their peoples may prosper. We must develop means to reduce both our costs and theirs — so more may buy.

The mass production started by Whitney — better, quicker, cheaper — is only beginning. It shall be continued and expanded by the groups of techniques we call "Automation," and improved control will be its most important phase.

SELECTION OF FLAVOR PANELS FOR COMPLEX DIFFERENCES

MAE-GOODWIN TARVER and BARBARA HALL ELLIS

Metal Division Research & Development Department

Continental Can Company, Inc., Chicago, Ill.

Introduction

Physical instruments are not available at this time to detect small differences in flavor of a food product. Human response, therefore, is still the most sensitive measure of flavor quality. Response to a flavor difference depends upon: (1) the precision or the inherent ability of a taster to duplicate a difference judgment; (2) the reliability of a taster or the absence of bias when detecting a flavor difference; and (3) the tolerance level of a taster or his inherent sensitivity to particular flavor differences. These three factors must be considered when flavor panel members are selected for flavor difference tests. They must also be considered when the data resulting from these difference tests are submitted to statistical analysis.

In two previous publications[1,2] a method was described for selecting beer panel members for difference tests based upon their sensitivity to bitterness. A method of this type is efficient and practical when the predominant flavor of the food or beverage is easily characterized by one of the four basic tastes. The flavor of many food products, however, is due to a complex mixture of odors, tastes, and mouth-feelings. No one basic taste is characteristic of this complex mixture. The purpose of this article is to describe a method for selecting flavor panel members for difference tests when complex flavors are present. Another purpose is to illustrate the statistical analysis of data obtained from these flavor difference tests. Data resulting from Two-Sample Difference Tests upon experimental packaging materials are used to illustrate the methods.

Food Products and Test Method

Frozen orange juice concentrate was selected for this study of experimental packaging materials because the characteristic flavor of this product contains sweet, sour, and aromatic components. The frozen concentrate was reconstituted to its original strength before serving. The flavor test method used in this study was the Two-Sample Difference Test.[2]

ASQC LCS Codes 520:710:70:420

Experimental Design

Three experimental packaging materials, i.e., experimental containers, and a reference standard, i.e. the test control or commercial container, were packed in contact with frozen orange juice concentrate.

A pair of samples, the control and test variate, were served to each of 13 available tasters. In addition, a control-to-control pair were tasted by each of the tasters. Each taster was asked to determine the *degree of difference* between each pair of samples using the following difference scale:

Score	Description
0	No difference detected
1	Very slight difference
2	Slight difference
3	Moderate difference
4	Large difference
5	Extremely large difference

On the data sheets, this degree of difference scale was printed as a vertical structured scale.[2] This type of scale arrangement encourages the use of fractional difference scores, e.g., 0.25 or 0.50. Tasters were permitted to use fractional difference scores because previous studies indicated that such a response to flavor differences is characteristic of an individual taster and is reflected in his precision.[1]

Duplicate sets of each pair were included in the test. However, only two pairs (four samples) were tasted at any one time to avoid taste fatigue. The duplicate pairs of a specific test variate, therefore, were randomized with respect to time of tasting.

The control sample of a pair was identified for each taster. This is a desirable procedure since this reference point aids the taster in making accurate flavor-difference judgments. Taster bias, which can be created by this prior knowledge of the test, was evaluated by the control-to-control comparisons included in the test.

The formal experimental design of this Two-

Table I—Analysis of Variance of Flavor Difference Data. Control-to-Control Comparisons

Source of variation	Degrees of Freedom	Mean Square	F-Ratio
Among Tasters	8	0.0868	0.61 NS
Within Tasters (Random Error of Duplicates)	9	0.1424	....

Panel Average = 0.18; NS = Not Significant (Below 5% Level)

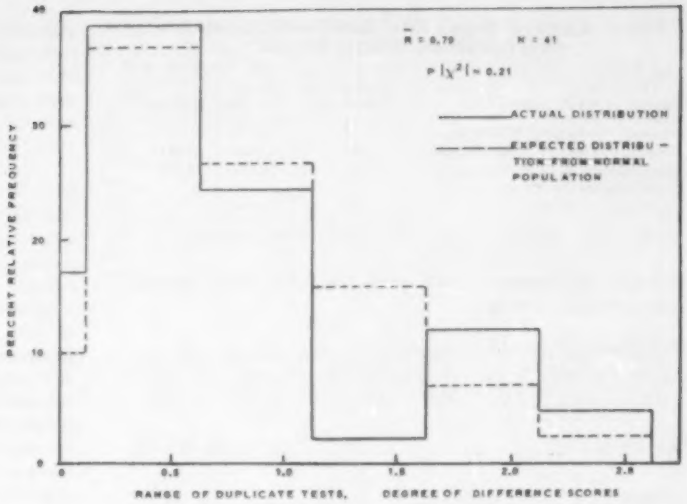
$\bar{R}$ = 0.79 N = 41
P [χ^2] = 0.21
ACTUAL DISTRIBUTION
EXPECTED DISTRIBUTION FROM NORMAL POPULATION
PERCENT RELATIVE FREQUENCY
RANGE OF DUPLICATE TESTS, DEGREE OF DIFFERENCE SCORES

Figure 1—Distribution of Ranges of Duplicate Tests: Two-Sample Difference Flavor Test. Thirteen Tasters—Three Packaging Materials Plus Reference Sample

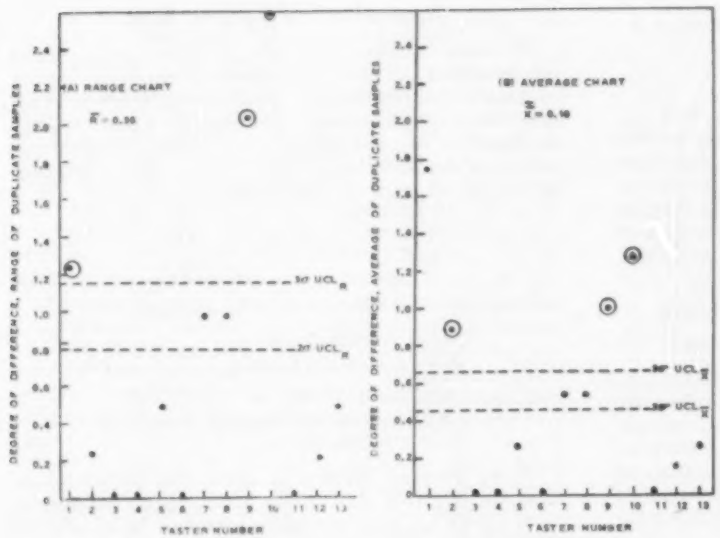

Figure 2—Statistical Control Charts for Control-to-Control Comparisons. Selection of a Precise, Unbiased Panel

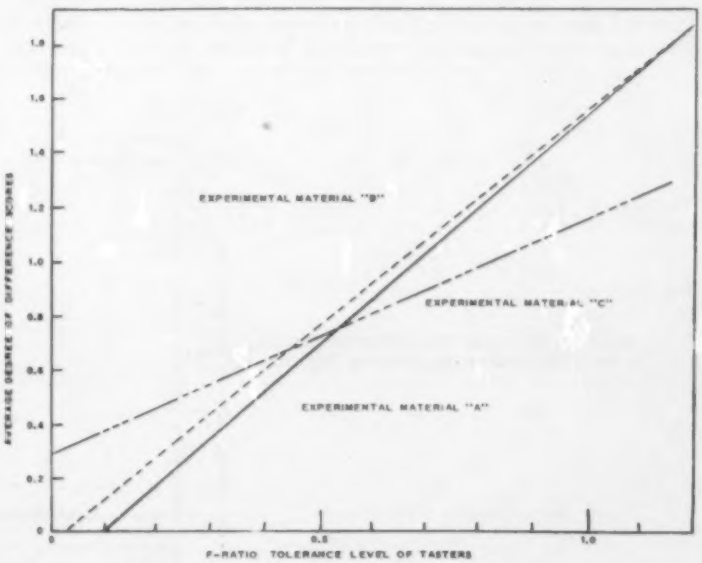

Figure 3—Individual Regression Lines for Two-Sample Difference Flavor Test. Three Experimental Packaging Materials

Table II—Analysis of Variance of Two Sample Difference Test Data. Three Experimental Packaging Materials

Source of Variation	Degrees of Freedom	Mean Square	F-Ratio
Among Packaging Materials	2	0.1830	....
Among Tasters Within Materials	24	0.1830	5.04**
Replications Within Tasters	27	0.4410	3.10*
Duplicate Error From Control-to-Control	9	0.1424	....

* = 5% Level (Trend) ** = Level (Critical Level)

Sample Difference Test was the following nested (hierarchal) design:

$C - x_a$ $C - x_b$ $C - x_c$ $C - C$

J1....J13 J1....J13 J1....J13 J1....J13

R1 R2 R1 R2.....R1 R2 R1 R2

Legend

$J =$ Taster number $= 13$

$x_a, x_b, x_c =$ Experimental packaging materials $= 3$

$C =$ Reference or control sample

$R1, R2 =$ Replications $= 2$

The special features of this design permitted (1) the detection of flavor-difference response in the precision of the tasters (mean square of the duplicate samples) and (2) an appraisal of the flavor-difference characteristics of the experimental packaging materials by regression analysis if the tasters showed a significantly different response within the materials.

Evaluation of Taster Precision From Control-to-Control Comparisons

Experimental evidence accumulated in this laboratory shows that the response to a flavor-difference sometimes appears in the precision of the tasters' difference scores as well as in the average difference scores.[1] For this reason, the *inherent* precision of the flavor panel must be evaluated in the *absence* of flavor-difference response, i.e., from the control-to-control comparisons included in the tests.

Statistical appraisal of taster precision assumes that the data were drawn from a normal population. Previous experimental data resulting from the Two-Sample Difference Test have shown no evidence of non-normality of the flavor-difference scores.[1] In this specific test, again no evidence of non-normality was observed. Figure 1 compares the actual distribution of the ranges of the duplicate samples run in this test with the expected distribution of the ranges if the samples were drawn from a normal population.[2] A Chi-square goodness-of-fit test between the actual and the expected distribution resulted in a probability of 0.21. This indicated no significant departure from normality of the flavor-difference scores. Therefore, the precision of the 13 tasters was evaluated by a statistical control chart for the range of the control-to-control pairs. This range chart, shown in Fig. 2(a), indicates that three tasters (Nos. 1,9, and 10) were not as precise as the remaining ten tasters. The ranges of these three tasters lay above the upper limit of the chart. The flavor-difference scores obtained from these three tasters were, therefore, deleted from the data in subsequent computations.

Appraisal of Taster Bias

The control chart for averages shown in Fig. (2b) assumes that the average difference resulting from a control-to-control comparison is expected to be zero if the taster is completely unbiased. However, chance fluctuations in the taster's judgment introduce a source of random bias. The upper limit for an average difference of zero is, therefore:

$$O + A_2\bar{R} = O + 3\frac{\bar{R}}{d_2\sqrt{n}} \qquad (1)$$

Where: $A_2 =$ a factor related to sample size[4]

$\bar{R} =$ average range

$d_2 =$ a factor related to sample size[4]

$n =$ sample size

$3 =$ a multiplier related to 99.73 percent probability

If an average difference score for a control-to-control pair lies above this upper limit, a taster is very likely to be significantly biased or to be affected by factors other than those included in the test conditions. Four biased tasters (No. 1, 2, 9, and 10) are shown in Fig. 2(b) and the flavor-difference data of the tasters were eliminated in subsequent statistical

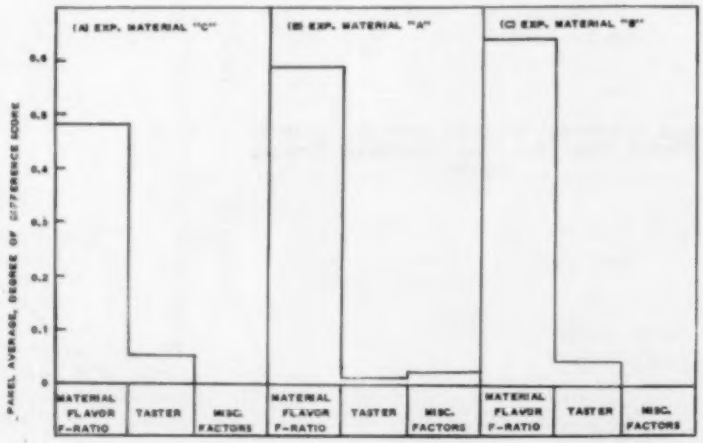

Figure 4—Continental Flavor-Difference Contours for Three Experimental Packaging Materials

Table III—Data from Two-Sample Difference Test Using Homogeneous, Unbiased Panel of Nine Tasters

Taster Number	Exp. Material "A"		Exp. Material "B"		Exp. Material "C"	
	F-ratio	*DIF. Score	F-ratio	*DIF. Score	F-ratio	*DIF. Score
3	0.05	0	0.98	1.75	0.28	0.75
4	0.05	0	0.50	0.25	0.05	0
5	0.74	1.500	0.50	0.50	0.25	0.50
6	0.50	0.250	0.05	0	0.50	0.50
7	0.90	1.250	0.12	0.25	1.12	1.25
8	0.50	0	0.50	1.00	0	0.50
11	1.00	2.000	1)	1.50	1.28	0.75
12	0.50	0.375	(0	0.25	0.10	0.25
13	0	0.250	0.25	0.50	0	0.25

*Average of Duplicate Two-Sample Difference Tests

analyses of the data obtained from the experimental packaging materials.

The control-to-control difference scores of the remaining nine panel members were submitted to the analysis of variance. The results of this analysis are shown in Table I and they indicate that a homogeneous panel of nine tasters was obtained in this test using orange juice concentrate.

Tasters' Tolerance Levels

If there is a significant difference among the difference scores assigned to one experimental packaging material, then the initially homogeneous panel of tasters is responding differently to the applied flavor-difference stimulus. The conclusions drawn from the statistical analysis shown in Table II are: (1) that the nine tasters have significantly different tolerance levels for the packaging materials and (2) that some of the flavor-difference response is appearing in the precision of the tasters. The first conclusion means that the tolerance level of each taster for each different packaging material must be calculated, while the second conclusion means that the random error for statistical tests of significance must be obtained from the control-to-control comparisons shown in Table I. The tolerance level of a taster to a specific packaging material is defined as the taster's ability to detect a difference between the control sample and a sample of the packaging material under test. The statistical F-ratio was satisfactorily used by R. G. H. Prince and J. H. Ince[5] to measure sensitivity to odors and was also used in this flavor-difference study to reflect the tolerance of each taster to the flavor-difference of the packaging materials. The F-ratio was calculated by the following equations:

$$F = \frac{MS_B}{MS_E} \qquad (2)$$

Where: MS_B = mean square between the control and the packaging material

MS_E = error mean square

$$MS_B = \frac{(\Sigma x_{c-c} - \Sigma x_{c-x})2}{2n} \qquad (3)$$

Where: Σx_{c-c} = sum of control-to-control comparisons

Σx_{c-x} = sum of control-to-variate comparisons

n = number of replications of each comparison

$$MS_E = \frac{\Sigma R^2}{2k} \qquad (4)$$

Where: ΣR^2 = sum of ranges squared of control-to-control and control-to-variate duplicate samples

k = number of ranges summed

(note: for duplicate samples *only*)

The F-ratios calculated in this manner are shown in Table III for each taster and for each of the three

Table IV—Analysis of Variance of Individual Regressions, F-Ratios and Difference Scores of Experimental Packaging Materials

	Exp. Material "A"			Exp. Material "B"			Exp. Material "C"		
Source of Variation	Degrees of Freedom	Mean Square	F-Ratio	Degrees of Freedom	Mean Square	F-Ratio	Degrees of Freedom	Mean Square	
Among Tasters	8	1.1406	.....	8	0.7500	.....	8	0.2640	.....
Due to Reg.	1	6.4576	16.95**	1	5.5338	80.09**	1	1.4784	16.35**
Dev. from Reg.	7	0.3810	2.68 NS	7	0.0666	0.47 NS	7	0.0904	0.63 NS
Dup. Error from Control-to-Control	9	0.1424	.....	9	0.1424	.....	9	0.1424	.....
(A) Panel Average		0.62			0.67			0.53	
Components of Flavor Contours	F-Ratio	(1) Basic Taster	(2) Misc. Factors	F-Ratio	(1) Basic Taster	(2) Misc. Factors	F-Ratio	(1) Basic Taster	(2) Misc. Factors
(B) Percent of Total Mean Squares (C) (A) X (B)	94.42%	2.09%	3.49%	94.04%	5.96%	0%	91.21%	8.79%	0%
Component of Avg. Score	0.59	0.01	0.02	0.63	0.04	0	0.48	0.05	0

NS = Significant (Below 5% Level): * = 5% Level (Trend): ** = 1% Level (Critical Level)
(1) Basic Taster = MS of Control-to-Control: True Random Error of Taster from Table I
(2) Calculated by Assuming MS of Control-to-Control Contains All Random Error of Tasters:
$MS_{DEV.} - MS_{DUP.}$ = Excess MS = Misc. Factors or Factors not Accounted for

experimental packaging materials. Individual tasters do not necessarily have the same tolerance level for the three different packaging materials.

Statistical Interpretation of the Test Data

The average flavor-difference scores assigned to the three experimental packaging materials are also shown in Table III. Since the analysis of variance shown in Table II indicates that a significant difference among tasters exists, differences among the three experimental packaging materials were determined by regression analysis. In the three separate regression analyses given in Table IV, the differences among tasters were partitioned into (1) the regression due to differences in tolerance levels and (2) the unexplained variation or the residual variance about the regression lines. Figure 3 illustrates the regression of the average difference scores of the three different packaging materials against the taster's tolerance levels. Each packaging material shows a significant correlation of difference scores with taster tolerance levels and the slope of each line is significantly different from zero, i.e., a significant difference was detected between the control sample (reference standard) and the three experimental materials. The true random or error term used in each analysis of variance was obtained from Table I.

An over-all comparison of the three different materials was made by the analysis of covariance[6] shown in Table V. There was no evidence of a significant difference between the slopes of Materials "A" and "B", indicating that the tasters reacted in a similar manner to these two materials. However, these two slopes were significantly steeper than the slope of the regression line for Material "C". The experimental interpretation of this difference among slopes was that the panel members found significantly larger flavor-differences, per unit tolerance level, between Materials "A" and "B" and the control or reference standard than between Material "C" and the control. Since Material "C" was the nearest approximation to the reference standard, it was retained for further testing. Materials "A" and "B" were deleted from the flavor-difference tests since additional information contained in quality scores indicated that the observed difference from the reference standard was a negative difference.

Continental Flavor-Difference Contours

The flavor-difference contours, shown in Fig. 4, were calculated from the information given in Table IV. The contours for Materials "A" and "B" show similar characteristics but are different from the contour for Material "C". This latter contour has a somewhat shorter Material Flavor bar, indicating that it is a closer approximation to the control or reference standard.

Summary

The precision and the bias of flavor panel members can be objectively appraised by standard statistical methods even in the presence of complex flavors. Unbiased tasters of similar precision can be selected under these conditions using machinery or instrument capability study techniques.

Tolerance levels for complex flavor-differences can be calculated for individual tasters for each material or product being tested. The F-ratio, based on control-variate comparisons, is a satisfactory measure of this tolerance level.

Differences among test variates can be evaluated by regression and covariance techniques. These methods are based upon the association between taster tolerance levels (F-ratios) and flavor-difference scores. Differences among taster tolerance levels, therefore, do not interfere with the interpretation of complex flavor-differences, provided that the tasters initially constitute a homogeneous, unbiased panel.

Flavor-difference contours can be drawn to show the principal components of complex flavor-differences. These contours are based upon the regression analyses employed in the appraisal of the data and permit visual comparisons of flavor-differences among the test materials. The contours are similar to those described in previous publications[1,2] although the contours described in this current article are limited to a maximum of three components.

Table V—Analysis of Covariance. Two-Sample Difference Test of Three Experimental Packaging Materials.

Source of Variation	Degrees of Freedom	Mean Square	F-Ratio
Improvement in Analysis Due to Use of Regression (Over Table II)	1	12.1278	54.61**
Deviations from Regression	23	0.2221	1.56 NS
Difference Among Slopes of Individual Regression	2	0.7209	4.02*
"A" vs. "B"	1	0.0564	0.32 NS
"A" + "B" vs. "C"	1	1.3854	7.72* (1)
Deviation from Individual Regression	21	0.1794	1.26 NS
Duplicate Error from Control-to-Control	9	0.1424	.....

NS=Not Significant (Below 5% Level); *=5% Level (Trend); **=1% (Critical Level)

Acknowledgements

The authors wish to thank Dr. R. E. Henry and Dr. B. H. Morgan for their assistance in the preparation of this article. They also wish to thank Mrs. A. M. Schenck for illustrations contained in this article.

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BOOK REVIEWS

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26 University Drive, East Lansing, Mich.

NONDESTRUCTIVE TESTING HANDBOOK—Edited by Robert C. McMaster. Published by the Ronald Press Co. Volumes I, II, pp. iii-3,000. Reviewed by Raymond A. Pulk, Defense Systems Division, General Motors Corp.

The field of nondestructive testing has undergone an accelerated growth since World War II, both laterally and in depth. This has resulted from increasing needs for methods to determine the properties of components and materials by virtue of hitherto unrequired applications and severe requirements. As a natural result, the need of a handbook which would place at the disposal of the engineer, scientist, technician, and inspector alike, information on fundamentals and application, becomes obvious. The Ronald Press, through the Society for Nondestructive Testing, has produced just such a work in the form of an indexed two volume edition.

For the quality control engineer, inspector, and manager, the first two sections of this handbook furnish a basic insight on nondestructive testing as governed by definition and its growth as an engineering field from a composite array of physical test methods. The broad reasons for its use are listed and explained and its role in quality assurance is pointedly noted. In establishing a quality assurance program, economic criteria for inclusion of nondestructive testing are tabulated and explained. Particularly utilizable is the section on nondestructive testing laboratories, which can furnish direction in the establishment of such a function as an integral unit in any organization. Valuable criteria are gained for the selection by management on reliance of commercial laboratories or the establishment of internal laboratories. In recognition of the fact that field testing has its own peculiar problems and headaches, an entire section is devoted to field and maintenance tests. For those interested in pressure vessels, pipelines, shipbuilding, and the chemical industries this section offers directional aids. Typical examples and methods employed are cited. Airline Fleet maintenance is explained somewhat in detail—an explanation which has value in that it may be transferred to parallel maintenance functions of other industries.

A complete section is devoted to defining and explaining nondestructive testing. The advantages, disadvantages, and limitations of nondestructive test methods are set forth in a tabular comparison with destructive test methods. In particular, the reliability of nondestructive testing is noted as critically dependent upon an intelligent appraisal of the correlation of the property being measured or detected and the properties controlling serviceability. This is indeed the basic underlying tenet one must accept in nondestructive testing as well as in any quality control test. Beginning with this section, the explanations of all test methods and principles throughout this handbook are based upon the physical principles involved in the probing media. These are (1) Motion of matter, (2) Transmission of energy, and (3) Combination of both. Developing this theme, the sources of probing media are treated, together with transducers and detector systems. The general industrial applications of each of these three physical systems are noted. Having a particular component, material, and serviceability requirement in mind, this treatment is a recourse in the handbook to which the quality control engineer should turn.

Four entire sections of this handbook are devoted to liquid penetrant tests, equipment, principles, and interpretation of indications. Five basic principles of any liquid penetrant method are cited, followed by a description of the mechanism involved in each method. Differentiation is made between the fluorescent water washable, fluorescent post-emulsification, and dye penetrant processes. Of particular advantage are the three tables listing the optimum applications of each method in terms of material, form, type of defect, and penetration time. Typical field applications and tabular presentations form the basis of evaluating the relative applicability and limitations of each penetrant method.

Equipment needs for penetrant methods are categorized as (1) Portable, (2) Stationary, and (3) Specialized high volume. The descriptive texts devoted to these units are adequately explained with photographs. The problems involved in equipment selection and maintenance are tabulated and explained, even to the point of emphasizing the importance of insuring the level of illumination of black light sources. Of equal importance to equipment knowledge, of course, is an awareness of proper material selection. This is gained by the criteria of major requirements of penetrants, i.e., (1) Ability to penetrate, (2) Removability, and (3) Visibility. These are explained in basic properties of viscosity, wettability, evaporativeness, and brilliance. Preparation of the penetrant is also emphasized, as well as the role and selection of proper developers.

The mechanism of penetrant flaw detection, and the production of indications are explained with the help of diagrams. The factors of diffusion, shape, distribution, and persistence are noted as important in intelligent interpretation. Of unique value are the tables which list and explain obscuring defects and irrelevant indications as related

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to the process in manufacturing, the effect of surface condition, and effect of penetrant technique on false indications. The difficulties peculiar to this process in organizing "standard comparison penetrant indications" are cited. Typical examples of the indications derived by the penetrant methods are shown by means of photographs.

A method related to penetrant technique — the so-called "filtered particle" method — is explained in a separate section. This is particularly applicable for the examination of clay, ceramic, and related products whose porosity is 100 mesh or smaller. The principles, and procedure are explained together with photographic presentations of indications and interpretations.

In the explanation of physical fundamentals, the handbook several times enters into detail, albeit explanations which are comprehensible and informative to one outside technical or scientific specialization. This applies particularly to the rather exhaustive treatment of the physics involved in vision, optics, and to the review of radiation and particle physics. One cannot escape the impression that he has recourse to a textbook without pedantics, resulting in source material for the quality control engineer and technician. The mechanisms of vision and principles of optics are categorically treated. The phenomena of interference, reflection, refraction, radiation, interferometry, are explained. Schlieren methods and diffraction techniques are adequately presented by the exposition of line-diagrams and typical patterns. Visual inspection equipment is covered in the categories of microscopy, telescopy, and electronic methods. The latter, of course, are amenable to measurement of intensity and signalling as well as vision aids. The treatment on optical projectors and comparators is comprehensive and well illustrated with typical instruments, as well as operational principle diagrams. For both routine and special techniques, this section is an excellent resource.

The technology of nondestructive testing has grown from a foundation most strongly and originally expressed in the application of penetrating radiation, which is possibly most controlled and prolific of the nondestructive test methods. Consequently, penetrating radiation has found a relatively wide scope of applications which involve specific techniques such as microradiography, x-ray diffraction, surface fluorescence, xeroradiography, and fluoroscopy. The wide diversity of specific techniques, and the interesting possibilities raised in broadening the applications, render necessary the isolation and understanding of many basic principles and test parameters. This fact is recognized by the editors who have comprehensively covered this subject. Beginning with a review of radiation and particle physics and a historical development of radiography techniques, an insight is furnished on the development principles, and selection of x-ray generators. In this connection, conventional generators and tube principles are explained, including the high energy sources such as the betatron, electrostatic generator, and linear accelerator.

The treatment on radioisotopes deals with four source materials, namely Cobalt, Iridium, Thulium, and Cesium. Some limitation is expressed here, since little or no mention is made of other radioisotopes such as Gadolinium, Samarium, Thallium, Ytterbium, and others which have seen some applications. It is also suggested, that radiographic sensitivity should not be confined to isotope radiography. Yet this subject appears in the section on isotopes as a rather incomplete presentation. Again, it is treated in the section on fluoroscopy, and still again in film radiography. This scattering of the full treatment is a disadvantage and tends to mitigate the importance and impact of understanding this concept.

The various mechanisms of radiation detection including ionization chambers, proportional counters, and Geiger-Mueller counters are explained. Absorption and luminescence mechanisms of phosphors and crystals are included in this explanation. The photographic processes involved in the absorption of x-ray photons by film are outlined in easily understood text, together with the basic roles exercised by intensification screens. The decision to insert this explanation in the same section as radiation detection appears somewhat arbitrary and the feeling is here expressed that a slight repetition or separation of a major topic is evident.

The techniques of x-ray diffraction and x-ray fluorescence analysis are indeed refined applications of penetrating radiation. An adequate insight is furnished to the technician on these methods, although detail in techniques is not as specific as other sections. However, it is recognized that these methods are extremely pointed in application and such detail would be possibly beyond the scope of an all-encompassing handbook. Very good examples are offered and illustrated in the use of x-rays and isotopes for thickness gaging. The fundamentals of absorption and sensitivity are explained in both text and mathematical form. The examples of the use of these techniques, the explanation of fundamentals, and the mass absorption tables render this an extremely applicable section.

Fluoroscopy and x-ray imaging devices are covered thoroughly in a well-edited section, with a comprehensive reference listing. In explaining the applicability and limitations of fluoroscopy, the effect on fundamental sensitivity is demonstrated. The factors of geometric and screen unsharpness are considered as limiting the minimum perceptible defect size. In turn, the limitations imposed by brightness response and contrast are also explained, and resultant sensitivity compared to film radiography. Again this is amplified by pointing out screen characteristics such as brightness response, absorption, unsharpness, and spectral emission of the light forming the image. Together with a treatment of electronic devices, such as the image tubes and direct photoconductive pickup tube, the role of light amplifiers is explained, although not in detail which would reflect trends in the past year or so. A valuable tabulation of fluoroscopy application areas is included in this section. It is highly recommended that this area of the handbook be not only consulted but thoroughly read by the potential user of a fluoroscopy system.

As noted previously, the material dealing with film is extensive, with a complete section devoted to exposure fundamentals, techniques,

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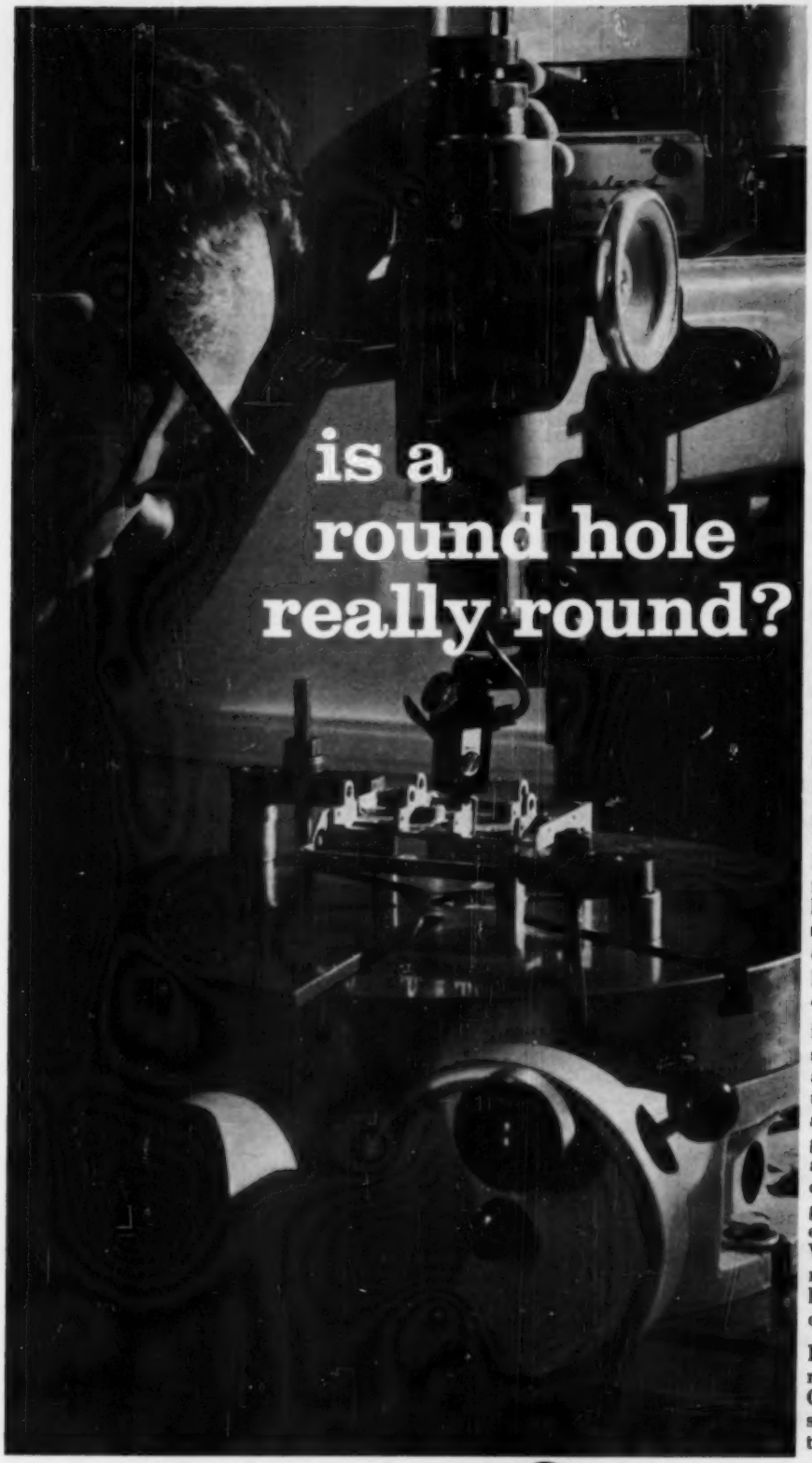

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the function of screens, scattered radiation effects, and special radiographic techniques. The explanation of radiographic sensitivity is considerably clarified by presentation of contrast and definition factors in tabular form. Film processing including automatic systems, is explained in an extremely practical vein. Valuable information, including typical layout plans, is offered to the prospective user of a radiographic facility. An excellent review of the capabilities and limitations of the xeroradiography process is furnished in a single section. This process briefly substitutes electrostatic image for film. It should be noted, however, that this section is restricted by (1) penetrameter tests extending only through 1958 and (2) no economic comparison with conventional techniques.

Although, by its own admission the handbook states that high voltage radiography is a straight-forward extension of lower voltage practice, the characteristics of generators above one MEV are presented. Recourse to the table listing the characteristics of megavoltage equipment is particularly recommended for the potential or existent user. A suggestion could be made that the table include at least two more sources of European design and manufacture.

It is noteworthy and important that the results of any closely controlled radiographic process are entirely at the mercy of the vagaries and unpredictability of interpretation. This is well recognized and intelligently treated in the handbook. Philosophically, the reader is cautioned on the basis of judgement of the item. This basis is soundness and not perfection. Sufficient or insufficient soundness cannot be judged by the inspector without an intelligent predetermination of the effects that discontinuities have on useability. To establish this correlation, acceptance quality levels must be first established. The theme is well developed and reinforced throughout with practical illustrations and descriptions of radiographs. This section more than typifies the general practical utility of the handbook.

Because of their usually critical nature, structural and pressure welds offer extreme susceptibility to discontinuities over and above that exhibited by wrought and cast alloys. Consequently, refined radiographic techniques and special comparison radiograph sets have been established by various organizations and services. In addition to service requirements a firm understanding of the welding technique is necessary for proper interpretation. The various discontinuities, both internal and external, of butt welds are explained and shown in radiographic reproductions. Special techniques for pipeline radiography, including isotopes, are also outlined.

The radiography treatment of the handbook is made complete by a section on safety, including personnel and special requirements, and another section listing attenuation coefficients of 40 elements. These tables are particularly valuable when used in conjunction with the section on radiation and particle physics for both research studies and in the selection of optimum energy range for radiography or fluoroscopy.

The wide diversity of materials capable of evaluation by nondestructive methods is exemplified by the application of the electrified particle test. This technique can be applied to ceramic materials, plastics, glass, and paint films—materials which by their uniqueness would not strike the average inspector as being amenable to nondestructive techniques, over and above visual inspection. Again, the handbook explains the principles, equipment, technique, and application of this method. Process control procedures are explained with an entire section devoted to sensitivity, indications, and interpretations. The latter is substantiated with illustrations and categorical explanations of such mechanisms as crack growth in glass and porcelain enamel failure.

Magnetic particle testing, especially during and since World War II, has been intensively and increasingly applied, particularly to the inspection of wrought steel components. Recognition of its wide application and importance has been demonstrated by rigid certification procedures for operating personnel and equipment, established by the government services. The handbook takes cognizance of this importance in devoting three entire sections to magnetic particle testing. It is considered by the reviewer that the explanation of basic fundamentals, magnetic field principles, and procedures is probably the most readily understood of all sections. In the selection of test equipment, criteria are categorically listed and explained. The illustrative material, descriptions, and characteristics which follow establish a basis of equipment selection by relating to the categorical listing.

Indications are grouped into (1) surface (2) subsurface and (3) nonrelevant magnetic disturbances. This theme is then well developed in the balance of the section. Illustrative examples and text material is outstanding, including non-metallic inclusions, seams, cooling cracks, lam-

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inations, forging laps, and weld defects.

Magnetic field test principles, which essentially measure absolutely or differentially the induced magnetic field of a specimen, are explained in accordance with field probe principles. These include general field strength measurements, field differential measurements, components of the gradient measurements, and small zone tests. Although the material is excellent and extremely informative, it is suggested that the section could initially emphasize to a greater degree the fundamental principles, particularly directed toward the technician and inspector. It is felt, for instance, that the magnetization curve should precede a listing of probe types. Notwithstanding, however, the material on probe coil operation, magnetic field meters, and Hall generator meters is outstanding.

The potentially numerous applications of magnetic field test equipment are well demonstrated by the fact that the coercive force and permeability of ferromagnetic materials vary by a factor of one hundred thousand over the metallurgical range. This is further amplified by an explanation of the principles involved in coercive force and permeability measurements and an explanation of the equipment. Automated control processes such as hardness sorting of hardened steel parts, case depth measurement, and chemical composition are shown as examples of the highly specialized uses to which this technique can be applied.

Electric current test principles are shown to reside in a rather simple and fundamental expression which relates the ratio of produced voltage to current between two electrodes to the geometry of the specimen. This method is particularly adaptable to test objects possessing homogeneous and isotropic electrical resistivity. However, it is demonstrated that the existence of anomalies which interfere with the phenomenon offers an interesting prospect for the determination of such anomalies. An adequate explanation of the four probe system is offered with diagrams showing wall thickness and crack measurement techniques.

Eddy current techniques in nondestructive testing have experienced a tremendous growth in applications in the past ten years. This is a method which basically can be adapted to the isolation and determination of extremely specific parameters providing all other conditions are held constant. Seven complete sections are devoted to this subject, representing probably the most complete single source available on eddy current techniques and applications. The diagrammatic representations of coil and test object, coil characteristics, and magnetic field conditions, together with explanatory text are outstandingly complete. In simple tables, the methods of testing and the equipment are presented for solid cylinder, hollow tubes, spheres and ellipsoids, sheets, plates and insulating layers on plates. In subsequent sections, a full development of the principles, techniques, and interpretations of eddy currents as applied to each of these geometries is accomplished. These include test coil arrangements for feed-through systems, determination of cracks, and diameter measurements for both solid and hollow cylinders. A comparable development is followed on spheres and sheet materials.

Eddy current automation techniques, including sorting and conveyorizing, are treated in a single complete section. Eddy currents are especially suited to automation and production testing. Examples of automatic sorting systems are shown and explained from the aspect of utilizing defect or composition parameters. Eddy current test indications are related to the sensitivity and accuracy of the method, which in turn are governed by changes of conductivity, permeability, coercive force, and magnetic saturation produced by small parameter variations. The ranges of application of methods involving electrical conductivity, hysteresis loop, and comparator bridge tests are lucidly established. Crack testing of steel is treated in detail. The references alone are an outstanding bibliography in the field of eddy current testing.

The handbook affords the same exhaustive treatment on explaining basic fundamentals of ultrasonics as is offered in radiography, magnetics, and electrical categories. Beginning with an easily understood

Computer Simulates Factory Operation

A new computer technique called "job shop simulation" is being used by Hughes Aircraft Company, Culver City, Calif., to eliminate costly trial-and-error methods of improving shop performance.

The simulation technique, which pre-tests various management plans for providing "more defense for less money," is being applied by the company's communications division which manufactures airborne and ground-based equipment for the U.S. Air Force, said Dr. John T. Pettit, director of Hughes' industrial dynamics.

The company is now gathering information needed to apply the same technique to simulate production of Falcon air-to-air guided missiles at its Tucson, Ariz., plant, and production of large airborne armament control systems for all-weather jet interceptors at its El Segundo, Cal., manufacturing facility.

An entire month's work can be represented on a computer in 15 minutes. Alternate management plans and key facts about a production line are entered on punch cards and fed into the computer, which digests the information, then spews out the results to be achieved from each of the proposed plans. Management then can select the best solution.

Spots Bottlenecks

In a recent test conducted at the communications division's machine shop, Hughes and IBM computer specialists set up several possible solutions to a known bottleneck to check the computer's ability to provide realistic answers to problems. They fed in information simulating such items as machine capacity, manpower levels and machining times. The computer quickly spotted the bottleneck and confirmed management's solution to the problem.

"The technique of simulation reduces uncertainty when management decides to make changes in the manufacturing plant, product flow and scheduling," said Ralph B. Reade, communications division manager. "With computer simulation, a manager can see his entire production line at a glance and study its operation on paper without undergoing costly trial-and-error experiments using actual men and machines."

Shop simulation has been under study for many years, but it was not until development of high speed, large capacity computers that simulation of huge, complex factories became possible. Since then techniques have been developed for reducing almost every aspect of production to computer language.

The use of simulation at Hughes is part of the company's corporate industrial dynamics program to avoid pie-in-the-sky concepts and, instead, place scientific management on a practical basis.

explanation of wave generation and propagation fundamentals, through explanations of basic instrumentation, and terminating in application and interpretation of indications, the handbook places at the disposal of the technician or inspector an extremely valuable source of information. Applicability and limitations of the method are discussed. Mode conversion, transmission, attenuation, and refraction are explained in diagrams and text. Chart presentations which explain the pulse echo, through transmission, and resonance techniques are included.

A complete section is devoted to ultrasonic transducers, including type, material, and construction. Focused and contoured transducers are shown. This is followed by a complete section on ultrasonic fields explaining transmission, reflection, and attenuation characteristics, as well as the significance of velocity. The influence of part contour and discontinuity on these properties is explained. Immersion ultrasonic test procedures are fully treated on the basis of principle and advantage and limitations. Complete A, B, and C scan presentations and their role in defect interpretation are set forth. This practical section is completed with references to test block calibration and examples of test indications in practical application such as airframe, engine, pipe, and tubing evaluation. Transmission and reflection techniques are treated in a section on contact testing. An insight into selection of optimum frequencies is furnished in tabular form fortified by a general guide in such selection. Valuable criteria for selection of couplants are also furnished.

The advantages and disadvantages of both the single and double transducer systems are presented to the reader. The reviewer finds that the description of inspection techniques, explanation of indications, and the interpretation of such indications is clear and useful.

The principle of resonance testing utilizing the phenomenon of standing wave formation and the resultant resonant vibration of the material, submits a fascinating and interesting method for studying material properties. The section explaining the basic fundamentals of this phenomenon goes further in test development history and suggestions for its successful application. Thickness measurement and discontinuities detection systems are outlined, with basic circuitry diagrams. Operating technique characteristics such as selection of frequency, instrument calibration, and surface preparation are adequately emphasized. The importance of this method for such sophisticated applications as corrosion detection, laminar flaw determination, and thickness measurement is presented with practical examples illustrating test techniques and interpretation. A parallel pattern is followed in natural frequency or sonic resonance testing utilizing frequencies below 20,000 cycles per second.

The principle of brittle coating tests indicates the direction and magnitude of strain by cracking of the coating normal to the load imposition. It is an excellent qualitative test which could locate points of strain-gage fastening for quantitative measurements. However, the handbook goes further than this, in outlining tests and procedures for measuring tension and compression strain. Basic principles, likewise, of photoelastic-coating tests are also developed in the handbook on the basis of fundamental and mathematical explanations. Test techniques, materials, and instrumentation are thoroughly classified and practical utility of these systems is well explained by the use of diagrams and photographs.

If one were to make any single conclusion upon review of these volumes, it would be the obvious conclusion that here is presented, for the first time, a compendium of the state-of-the-art of a comparatively new technology. The handbook furnishes an insight as a text to the inspector, technician, and student on the scope and basis of nondestructive testing. On the other hand it is educational to the manager, director, and administrator. The data tables, test method selection criteria, and interpretation phases are immeasurable aids to the engineer. Likewise, bibliography, references, and the *per se* outlines of the state-of-the-art represent valuable recourses for the scientist, physicist, and research worker who seeks to exploit the physical principles involved in the development of basic techniques.

A number of physical features of the handbook should be cited. Publication in two volumes is a slight handicap to handyness. However, the general outline of the work—section by section—is most excellent for accessibility, albeit some separation of topics such as sensitivity do occur. Some inescapable duplication is evident, but the reviewer found this to be an asset. The titles of each section are listed by number designation on the inside front cover of each volume, with an alphabetical section listing an excellent cross-index on the inside back cover. The detailed index of almost 100 pages is complete, handy, and easy to use. Boldface section numbers on each page are a decided convenience. The editor, publisher, and contributing staff are to be commended on an outstanding and monumental task, and from the standpoint of information, accuracy, editing, and format.

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NEW AMERICAN STANDARDS

The work of the Standards Committee of ASQC has resulted in the revision of several American War Standards (Z1.1-1941, Z1.2-1941, Z1.3-1942). These war standards have been revised, rehashed, and revised again. ASQC circulated these revised standards in a survey of organizations having a substantial interest in quality control. After further review of the war standards, in light of knowledge gained from the survey of industry, ASQC submitted the standards to the American Standards Association for approval as American Standards. The American Standards Association approved the standards as American Standards on November 21, 1958. . .

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What's New?

ROY A. WYLIE, *Editor*

601—Standard Gage Company has introduced a new line of air gages. Available in two models, #120 and #240, Standard Air Gaging Stands and Control Units have an adjustable magnification from 35:1 to 28,000:1, with a choice of 26 stock dials to choose from. Standard will offer a complete line of adjustable manual air gages as well as air plugs, air rings, fixtures and fully automatic "in process" and "post process" special gages.

* * *

602—A new fully automatic thermal shock machine for testing glass containers is now in production at the Banbury Equipment Corp. To perform a thermal shock test, the operator presets the temperature dials individually for two tanks, presets the desired time for immersion in each bath, places a metal basket filled with the units to be treated or cleaned on the carriage and pushes the start button. The carriage moves the load directly over the first tank and lowers it until fully immersed in liquid. At the preset time interval, the carriage raises the load out of the tank, moves it directly over the second tank, and lowers it for full immersion in this liquid for the preset time exposure. When time is up, the carriage raises the load out of the tank and moves it back to its starting position. From cycle start to cycle finish, the operator has full control and can stop the carriage at any point, override any position and return the carriage to its original position. The machine can also be controlled manually, if desired, for small quantity testing or processing. Controls include a Hot Tank Timer with a range of 18 seconds to ten minutes; a Cold Tank Timer ranging from five seconds to 150 seconds and a thermostat which controls the temperature within one degree plus or minus from 0°F. to 250°F. The machine measures 58 by 36 inches and weighs just under 1000 pounds. Tanks and fittings are made of stainless steel, although other tank liners such as lead or rubber can be substituted for special requirements. The standard unit with tank dimensions of 26 by 26 by 24 inches is priced at $3500. Other size tanks or modifications of the machine are available and will be quoted on request.

* * *

603—The Sutherland Ink Rub Tester for evaluating the scuffing and/or rubbing resistance of an ink film on paper and paperboard is designed to perform dry rub, wet rub, wet bleed or transfer, wet smear and functional rub tests. Few, if any, inks will pass rubbing, wet or dry, without a slight transfer of color. Decisions on the suitability of an ink are best made by running comparative tests, checking on acceptable sample at the same time and under the same conditions. Consideration must be given to the time interval between printing and testing, particularly with slow drying inks. Prints must be protected from dust and dirt between printing and testing.

* * *

604—A new Rex Rubber Hardness Gauge, Model 1600, with an easy-to-read dial for laboratory and production work has been introduced. It measures hardness of rubber and other elastomers instantly by holding the gauge in vertical position and pressing down until entire foot encounters specimen. Reading is given accurately to plus or minus ½ Durometer point ("A" scale). The gauge will produce readings consistently and indefinitely. Creep readings are easily noted by action of the dial hand. Weight of the hardness gauge is eight ounces, and it comes in an individual mahogany case.

* * *

606—A new completely portable, transistorized, battery-powered instrument for measuring surface finishes on metals, plastics, ceramics and organic materials has been added to the line of Brush Surfindicators. Precision measurements from one to 1000 microinches can be made at any point in a production line or inspection area with the 5½ pound unit. A new rugged pickup stylus capable of detecting variations of ½ microinch within the measurement range contains a transducer element which generates a current proportional to surface variations. As the stylus tip is moved over a test surface, small deflections are transmitted through a viscous fluid coupler to the current generator inside the pickup. For accurate measurements, the pickup is moved across the surface to be measured at the rate of ⅛ i.p.s. The pickup can be hand-held or mechanically driven with the Brush motor-drive unit. Minimum diameters of curved surfaces that can be checked without using a skid holder are ⅛ inch for O.D. and 5/16 inch for I.D. The stylus tip consists of a 0.005-inch radius sapphire. Possible errors which might result from surface waviness as distinguished from roughness are eliminated by wave-length "cut-offs,"

Danish Society for Quality Control Joins European Organization for QC

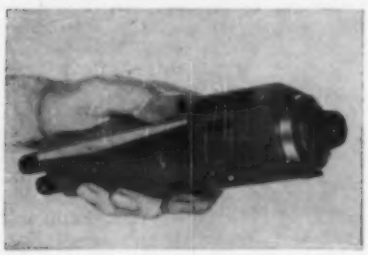
A group of Danish Industrial Engineers have announced the formation of the Danish Society for Quality Control.

The new association, with regard to increasing the competitiveness of the Danish industry, aims to disseminate knowledge of industrial quality control and industrial statistics, effect exchange of technical and commercial experiences among the members, keep members informed of developments in the area, and to obtain contact with similar organizations abroad.

The association became a member of the European Organization for Quality Control on Jan. 1, 1961.

The announcement was made by K. Haltou-Nielsen, secretary, Dansk Forening for Industriel Kvalitetskontrol, Hegnsvej 69, Naerum, Denmark.

which are adjustable for the particular surface under test. Three cut-off wavelengths provided for different ranges of work are 0.030, 0.010 and 0.003 inch. Surface deviation from a mean line can be computed either by arithmetical averaging or root mean square modes in accordance with approved ASA standards. Surface finish measurements are read directly on the Surfindicator meter. A profile of the surface can be obtained by connecting the Surfindicator output to a direct writing recorder through a jack provided on the back panel. A caliblock reference specimen with 125 and 20 microinch roughness patches is also included with the MS 1000 unit. The instrument is calibrated to these precision reference standards with a simple screw driver adjustment. Overall size of the unit is 6¾ by 7½ by 5 inches. Power is supplied by two nine-volt batteries. Price: $920.00



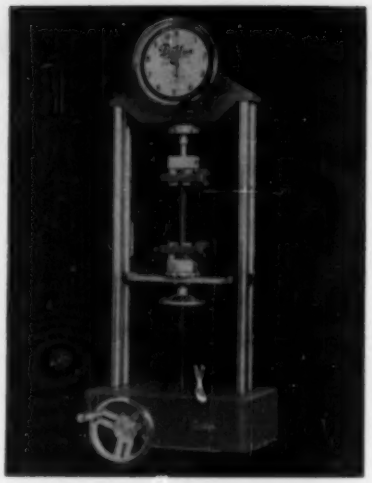
605—A portable instrument for safe testing of explosives and other heat sensitive devices is now available. The Model IRB-111 Impulse Resistance Bridge is a small, hand-held, self-powered unit designed to test propellant or cartridge-actuated devices in missile launch, separation or destruct packages. During ground check out, the Fleming impulse resistance bridge measures the circuit resistance to determine if the explosive system will do its job when called upon. Unlike existing testing devices which supply current at constant rates to explosives, the Fleming unit provides a single pulse of limited energy. A constant current flow applied to a bridgewire causes heat, which must be dissipated by the explosive itself. This could result in premature explosion leading to missile failure and in some cases, loss of life. When the handle of the IRB-111 is depressed, a single sensing pulse is applied for about 1 millisecond in duration. No more than four pulses can be generated per second. While depressing the handle, the direct reading 10-turn dial is rotated until the indicator lamp goes off or on. At that time, the resistance of the circuit within a range from 0 to 10 ohms can be read directly on the dial to an accuracy of ±2% ±0.02 ohms. Other models provide a wide variety of ranges. In addition to use in checking explosives in missiles and space vehicles, the Fleming units can be used in aircraft electrical check-out, and by industrial laboratories and manufacturers for testing with complete safety any device in which heating effects may be undesirable, harmful or dangerous.

* * *

609—Lightweight construction and low equipment cost are features of a new series of vibration tables developed by the L.A.B. Corporation. The tables were developed specifically for reliability testing programs for electronic equipment, and are available in two series—RH-5220 for horizontal vibration and RV-5340 for vertical vibration. The machines produce simple harmonic table motion and employ the reaction principle of vibration with the tables supported by spring and cable suspension systems. This feature isolates all vibrations from the floor and eliminates the necessity of concrete foundations to anchor the machine. The vibration generators are attached directly to the table structure and are driven by variable speed drives through drive shafts. Generators are of the constant displacement type and adjustments of displacements are made at stand-still. Standard frequency range is 25 plus or minus 5 C.P.S. Frequency can be adjusted manually while the machine is operating. The relative lightweight construction of the new vibration tables makes them well suited for environmental chamber installations, and units with standard components are operable in temperatures ranging from −40°F. to +160°C. Each series has a maximum test load capacity of 500 pounds per table. Tables are available in a wide variety of sizes. The RV-5340 will produce 3.6 G's and the RH-5220, 3.2 G's. Both series of machines are priced in a range from $4000 to $7000, depending on size and equipment.

* * *

610—The Armcorp Portable Differential Pressure Tester and Calibrator provides a means of checking gauges, flowmeters, transducers, regulating units and other equipments that operate on differential pressure principles. It incorporates its own pressure sources for applying accurately measured pressures in discrete increments. It permits checking installed equipment from a remote position without compromising the accuracy of the test. The differential pressure range is 600 inches of water. Accuracy of the basic model 1267 calibrator is ±0.03 inch of water, and with a 0.1 percent Dial Manometer, it is ±0.15 inch of water. Sensitivity is ±0.027 inch of water. The unit is self-contained with a light-weight, removable aluminum carrying case 24 by 18 by 20 inches, and weight is 45 pounds. Variations of the Model 1267 are available on special order to accommodate a variety of pressure ranges and test conditions.



607—Extra large sections of materials can be easily positioned and tested in a new Dillon Model LW extra wide tester. Standard width between the uprights has been increased approximately 80 percent, from 8¾ to 14½ inches. In addition to this extra wide work area, four daylight openings are available (12 inch, 20 inch, 30 inch, 40 inch) to permit fixture travel in excess of the greatest anticipated elongation. These new Dillon instruments are made in seven capacities: 0-250#, 0-500#, 0-1000#, 0-2500#, 0-5000#, 0-7500# and 0-10000#. Tests of tensile, transverse, compression and shear can be made on materials with tensile strength varying from only a few pounds to as high as 400,000 psi. All capacities can be supplied with a steel stand or may be used as bench models, motorized or handwheel operated, with a wide selection of gripping fixtures.

* * *

608—A new higher capacity Electrobalance is now available for use in weighing small parts, checking the operating of tabletting presses and other forming machines. It is also useful for determining the denier of fiber, from fine to coarse, for testing wire size, for weighing samples for routine chemical analysis and for mixing and blending materials. It can be used to check the amount of material removed in grinding, or the amount added in plating small parts. The new Cahn Gram Electrobalance weighs samples up to 1.2 grams and can weigh small samples to an accuracy of one microgram. A single weight dial reads directly in milligrams or micrograms. All operating adjustments are on the front panel, and operating instructions are printed on the case. It does not require a special balance table nor a special balance room, as some high accuracy balances do. It is hand-portable and special training is not required, even to weigh

to one microgram. Special circuits eliminate computation, such as subtracting container weight, etc. Eleven ranges, selected by panel switch and choice of loops allows the operator to set the full-scale range from 0-1 mg to 0-1 gram. An elastic ribbon suspension instead of knife edges or pivots is used to eliminate bearing friction. The Electrobalance is available with battery power for portable operation or with a new silicon solid-state power supply for those applications requiring exceptional long-term stability without adjustment.

* * *

611—Genisco, Inc. has developed an extremely precise, electronically speed-controlled centrifuge, the Model B931 G-Accelerator, for research and development applications, product reliability tests, checkout of commercial guidance packages, and production component evaluation. Order of precision of the Model 931 is indicated by a 0.001 percent allowable drift from angular velocity of either the main rotating arm or the outboard table. This is achieved through use of a crystal-controlled oscillator to determine setting accuracy. The B931 provides any discrete operating channels up to 30 g's. These speeds are adjustable, preset to customer specifications. The G-Accelerator may be set up to maintain a spatially stable platform for the test object or to create several discrete and very accurate sinusoidal or constant g-accelerations. Operating modes include fixed azimuth orientation. Both rotating arm assembly and rotating outboard table have individual drive motors. These special synchronous units are directly coupled to the shafts to minimize mechanical noise and vibration. They also exhibit excellent damping characteristics which reduce spurious transients. Nominal radius of the rotating arm is 24 inches between its center of rotation and that of the outboard table, which is 8 inches in diameter. Maximum loading capacities: Fixed mounting platform, 25 lbs.; outboard table, ten lbs. A model similar to the B931 is available without the variable speed outboard table.

* * *

612—A new dc voltage standard and null voltmeter, the Kin Tel 302, is an extremely accurate and compact source of variable voltage low-impedance DC. Standard cell stability on the 302 is obtained through the use of Kin Tel's chopper circuit, which constantly compares the output against an internal mercury-cadmium standard cell. Short-term stability is better than 25 parts per million and stability over a 30-day period is better than 50 parts per million. Precision voltage adjustment is accomplished using six detented dials. Voltage settings can be made in one millivolt increments. Up to 20 milliamperes of current are available at any output from 1.000 to 502.110 volts. The self-contained null voltmeter makes laboratory-accurate measurements which show the difference between the 302 output and an unknown input voltage. The floating output is isolated from the cabinet ground; resistance between the cabinet and either output lead is greater than 1000 megohms. The effective output impedance is less than 0.01 ohms for DC, less than 0.2 ohms at 1000 cps.

* * *

614—Torque and power loading of electric motors may now be measured on the job, using a new pocket-size dynamometer. The instrument is slipped onto a shaft and the collet tightened by hand. Interchangeable collets accurately fit a wide range of shaft sizes. A self-contained V-belt pulley is adjustable from two to 3½ inches diameter. An adapter is provided for direct drive to hubs, spokes, gears, etc. In operation the dynamometer is viewed by a stroboscopic tachometer while rotating. Transmitted torque is read from the dynamometer dial, and RPM is read from the stroboscope dial. Horsepower may then be easily calculated, or read from a chart. The instrument indicates torque up to twenty-two inch-pounds in either direction with an accuracy of within one-half percent. The mechanism is protected by shock absorbing internal stops against overloading caused by the initial starting surge of the motor.

* * *

615—The Dipolemeter DM 01 is a precision measuring instrument designed for the evaluation of the molecular electrical dipole moment of liquids by accurate measurement of the dielectric constant. It further permits exact determinations of the dielectric constant of liquids, pastes, and solids for non-destructive quality control, purity test, dielectric analyses, chemical investigations, etc., because of its extremely sensitive measuring range ($2 \cdot 10^{-5}$ for liquids). Interchangeable cells and micrometer electrodes are available for the various media and substances to be analyzed.

Case Histories On Statistical Methods For Quality Control

Series II *(Regression, Correlation and Association)*

$1.00

Prepared by the Metals Technical Committee of the American Society for Quality Control

Published in April 1960 by the American Iron and Steel Institute

This second series of case histories features the use of committee Standard Data. By keeping data constant, the study is focused on comparison of methods.

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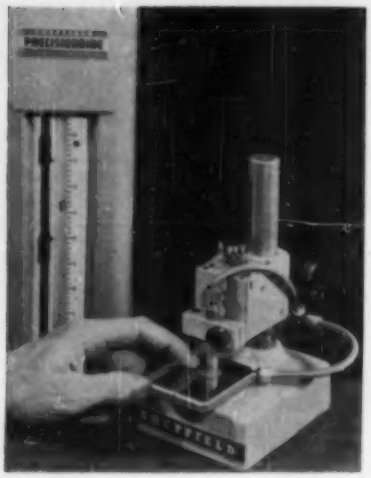

613—Designed to measure the thickness of thin, fragile materials, such as semiconductor wafers and dice of germanium and silicon without gage point pressure, a new Precisionaire Non-Contact Thickness Gage literally floats the part in air during gaging. The pressure-free gaging operation is obtained by means of opposed airejets; one is in the head, the other in the anvil. The air flowing out of the jets calipers the part to give accurate, repeatable thickness indication by the position of the float in the Precisionaire column. The instrument can be used also to measure the thickness of plastic film, sheet rubber, thin glass and other materials. Polished metal can be checked without fear of scratching. The gage head has both fine and coarse adjustments. It is adjustable from 0.0001 to four inches. There are two standard models; specials will be quoted. Model No. 604-TGF has a foot pedal to turn the air on and off to facilitate loading very thin materials into gaging position while Model No. 604-TFC instrument has no foot pedal, so that air flow is continuous. The gage is calibrated with minimum and maximum size parts; no masters are required.

Literature Available

630—A new two page bulletin on depth gages and adjustable length gages is available from Unigage Corp. The adjustable length gage is designed to handle a wide range of length measurements and is adaptable to many applications. The illustrated bulletin shows many of the combinations in which the gage can be used. The depth gages are for small hole use and routine depth measurements.

* * *

631—Bulletin 8009 describes Universal Plugs for Moore Pneumatic Comparator Gages.

632—Two illustrated folders explaining the new Nomarski Polarization Interferometer and the Interference Contrast Technique are available from the William J. Hacker & Co., Inc.

* * *

633—J. T. Slocomb Company's direct reading micrometer, the Speedmike and the Snap Gage Micrometer, are described in detailed fashion in a new catalog sheet recently issued by the manufacturer. The literature includes information on the advantages of direct reading micrometers over conventional types and explains how the Snap Gage Micrometer may be used to eliminate an entire set of fixed snap gages. Information on optional features and optional terminals available is also included.

* * *

634—A 32-page illustrated brochure describes the new, 1300 page ASM *Metals Handbook*, 8th Edition, Vol. 1, "Properties and Selection of Metals." Actual examples from each of six major sections are presented, with documentary information on how the book was compiled by 1335 ASM members from every area of industry.

* * *

635 — Features, applications, and specifications of the Beckman Model G and GS pH Meters are reported in a new descriptive bulletin published by the manufacturer. The Model G is used for research analyses, routine pH and millivolt determinations, and quality control applications. Beckman's Model GS pH Meter is a modification of the Model G, employing two additional operating controls to provide 20 times greater meter sensitivity and an eight-fold increase in readability.

* * *

636—A new 64-page catalog of replacement parts and spares for its high precision, dial indicator gages and setmasters is now available from Boice Gages, Inc. Large exploded drawings of each gage permit quick reference to part names, part numbers and prices. Facing pages offer precise instructions for disassembly, reassembly and setting of the gages, with each step numbered in sequence.

* * *

637—A new 12-page torque measuring instruments brochure illustrates how to measure the torque characteristics and speed of motors, gear trains, servo mechanisms, potentiometers. It covers torque ranges from ¼ gm-cm to 200 lb.in., and includes formulas for computing power and efficiency and methods of using stroboscopes and tachometers for analyzing rotating motion.

Professor Lloyd A. Knowler Scholarship Established at State University of Iowa

The State University of Iowa Section is pleased to announce the establishment of the Professor Lloyd A. Knowler Scholarship Fund at the State University of Iowa, Iowa City, Iowa.

The Scholarship Fund in the amount of $7,500 has been turned over to the State University of Iowa Foundation. The earnings on this sum will determine the amount of money available each year for a Scholarship. The first such Scholarship should be available for the fall term of the 1962 school year.

This Scholarship is to be a full tuition grant, with the recipient required to be a Junior or Senior student in the Department of Science, Engineering or Administration. The University will select the recipient in accordance with their established procedures and requirements.

Professor Lloyd A. Knowler, Chairman, Department of Mathematics and Astronomy, State University of Iowa, is well known as a director and staff member for short courses in Quality Control presented at Iowa and several other Universities. He has also served as a consultant in the field of statistical and quality control problems for numerous industrial firms and governmental agencies. Professor Knowler is currently on a leave of absence, serving as a consultant to the Bureau of Census. He is working primarily in the Far East, and has been recently stationed in Calcutta, India.

section briefs

AKRON-CANTON . . . Elected Mar. 16: chairman—Delmer C. Dague, Hoover Co.; vice chairman—Dr. Clyde H. Walden, General Tire and Rubber Co.; secretary—James F. Davis, Firestone Tire, and treasurer—Wendell D. Kegg, Alliance Manufacturing Co.

Committee chairmen: program—Dr. Walden; membership—Harold Baker, Hoover Co., and Donald L. Pursley, U. S. Stoneware; publicity—H. Paul Pierce, Timken Roller Bearing Co.; education — Robert M. Archer, Hoover Co.; arrangements—Robert C. Sigrist, General Tire and Rubber Co.; ACESS representative—Dr. Walden and Hubert Lewis, B. F. Goodrich Co., and general conference—Mr. Kegg.

The late arrival of Bernard J. Cunningham, Minneapolis-Honeywell, was handled admirably by Messrs. Walden, Halsey, and Church, who bridged the gap with an interesting discussion of the QC activity and organization at General Tire and Rubber Co.

Mr. Cunningham presented "Non-Destructive Testing." His slide presentation of ultra-sonics, X-ray, and eddy-current testing was very effective in introducing the group to the latest techniques.

H. P. Pierce

ALBANY . . . Mar. 2, Ladies' Night . . . To present a statistical program that is interesting to these gals—even though they have been somewhat oriented by being married to statisticians—is no mean task . . . Thanks to Nick Demos, General Electric Co., Schenectady, N. Y., the wives and husbands both enjoyed the application of the factory control chart to household problems . . .

It is suspected that we will be seeing more trim waist lines and a lot of smiling faces now that Nick has brought problems like diet and budget into control.

June 1, our last meeting of the season will be held at the Hot Shoppe in Albany . . . Don Holmes of the General Electric Co., and past president of this section, will present a comprehensive study of the "V" Notch Control System . . . It is hoped that we will have the largest attendance for this final meeting—we saved the best until last . . .

Have a very enjoyable and safe summer—see you in the fall.

M. P. Flanagan

ALLENTOWN-BETHLEHEM . . . Mar. 8, the Reading subsection hosted the parent section at the Hotel Abraham Lincoln . . . An "old home week" atmosphere prevailed as many old acquaintances were renewed . . .

R. G. Mitchell, International Latex Corp., Dover, Dela., spoke to the combined group on "Quality Control —The Seeing Eye of Production."

Another eight-week course in Sampling Inspection, conducted by the section, was begun Mar. 13 at Muhlenberg College.

David F. Roberts

BALTIMORE . . . Mar. 21, plant tour, Quality Assurance Technical Agency Laboratories, U. S. Army Chemical Corps, Army Chemical Center, Md. . . .

Messrs. Ellner and Hurwitz of the Army Chemical Center did an excellent job on arrangements—which included the displays welcoming our group, an excellent dinner, and the tour through the modern inspection laboratories—the envy of most industrial establishments.

In the metrology laboratory the use of optical comparators was demonstrated, and precise gages and measuring devices were displayed.

The chemical and physical test laboratories displayed a complex setup of chemical and physical equipment for testing material properties.

The non-destructive test laboratory featured the use of x-ray equipment in determining weld defects and the use of an eddy current test device for evaluating the properties of a product subjected to heat treatment.

A. M. Reek

BOSTON . . . Mar. 9, annual meeting, reports were submitted by section officers and committee chairmen . . . "Recruiting, Training and Development of Engineers" was covered by C. Gadzinski, Raytheon Co.; J. Truscher, Carter's Ink, and D. Conant, Frank C. Brown Inc., Management Consultants . . .

H. L. Keefe

BUFFALO . . . Mar. 27, plant tour, Hooker Research Center, Grand Island, N. Y. . . . This was also Ladies' Night . . . A short business meeting before the tour included nomination of officers . . .

The new four-million dollar plant, completed in January 1959, is one of the most modern laboratories in this area. Twenty-two spacious laboratories of modular design occupy two floors of the building, which has a personnel capacity of 200.

The tour included a demonstration of the formation of a Hooker Urethane Foam.

Dr. Irving Gordon

CHARLESTON . . . Mar. 16, Warren R. Purcell, Raytheon Co., presented a most interesting talk . . . His

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subject "Pursuit of Facts" piqued the interest of the members present, especially since it concerned the use of multi-factor analysis which is "near and dear to the hearts" of those who are in the chemical industry . . .

F. T. Simon

CHATTANOOGA . . . Mar. 13, annual Management Night, Wimberly Inn, 20 guests from management ranks of local industries heard "What Management Expects of QC" by Carl Borden, plant manager, Chattanooga Nylon plant, E. I. Du Pont de Nemours & Co., Inc. . . .

John L. Rose, Jr.

CHICAGO . . . Apr. 5, severe weather conditions prevented our previously scheduled speaker from reaching Chicago for our general meeting . . .

Substitute speaker was William Golomski, chairman of the Food and Allied Industries Division, ASQC, and past chairman of the Milwaukee section, ASQC.

His presentation, "Analysis of Bulk Sampling and Mixing" included a review of various methods used in bulk sampling, including analysis of machine capabilities with regard to mixing performance on granular and emulsion type products.

There are no general meetings scheduled for June, July and August—which brings to mind that the 1960-61 season passed all too quickly. It must have been the mild winter which we experienced in Chicago—or does time pass more swiftly with age? (I hope not!)

Election of section officers for 1961-62 season will be held shortly. I'll keep you posted on this and other happenings concerning the section.

John Dittrich

CLEVELAND . . . Mar. 3, the section's executive committee voted to conduct an All Day Conference this coming fall . . . The exact time and place will be announced later . . .

Effective July 1, Dr. Lloyd S. Nelson will become National Director. Dr. Nelson will also become chairman of the Cleveland section on the same day. He replaces Stephen C. Bates, who has served as National Director for the past ten years.

The executive committee, in behalf of the Cleveland section, presented Mr. Bates with a Fellow grade tie clasp to show its appreciation for his long years of service to the section and to the Society.

Howard O. Schmidt

COLUMBUS . . . Mar. 15, plant tour, Ternstedt Division, General Motors Corp. . . .

Ternstedt is the world's largest manufacturer of automotive hardware. The tour was very interesting and attracted a good turnout.

G. E. Arris

CORNING-ELMIRA . . . Mar. 14, Baron Steuben Hotel, Corning, N.Y. . . . Our originally scheduled speaker, Ogden McMahon, National Homes, was unable to attend our meeting . . . Substituting for Mr. McMahon was David Gentry, also of National Homes, who spoke on "Human Relations at Home and at Work" . . .

June 17, Annual Outing, time and place to be announced . . .

Richard Gibson

DALLAS-FORT WORTH . . . Mar. 7, the management development committee conducted a special meeting to complete a program which was designed to attract new industry to the area . . . Section members and managers from 30 industries not previously represented in section activities were invited to this meeting . . . The meeting attracted executives from 32 companies which had not been represented in the section . . . Dr. J. M. Juran spoke to more than 100 members and guests.

Mar. 23, Dr. R. C. McMaster, Ohio State University, spoke to 63 attendees on "Non-Destructive Testing's Role in Quality Control," during a joint meeting with the North Texas Chapter, SNT . . .

Mar. 25, the section's Sixth Annual Symposium at Southern Methodist University was a huge success . . . More than 180 registrants had their choice of nine speakers . . . The highlight of the day was a general assembly with Dr. McMaster . . .

R. R. Massegee

Officers elected at the Mar. 1 meeting of the Harrisburg section from the left are treasurer—R. Lehman, Carlisle Tire and Rubber Co., Carlisle, Pa.; chairman—H. Gross, RCA, Lancaster, Pa., and secretary—J. Fasnacht, Hamilton Watch Co., Lancaster, Pa., who was re-elected for a second term. Vice chairman O. Fox, Borg Warner, York, Pa., was absent when the photo was taken.

DAYTON . . . Mar. 4 brought to the Dayton Section's All Day Conference 251 attendees from throughout the United States . . . Dieter Grau, NASA-Marshall Space Center, Huntsville, Ala., presented the dinner address.

The planning committee deserves praise for their efforts at the Biltmore Hotel, Dayton, Ohio.

Mar. 9, the section held their regular technical meeting at the Standard Register Co., Dayton, Ohio . . . "Small Lot and Short Run Quality Control," was presented by E. B. Godsey, Collins Radio Co. . . .

July 8, the program committee is planning a well-rounded entertainment program for the section picnic . . . This promises a change from our usual studious and absorbed interest in technical programs . . .

Harleigh F. Diehl

GREATER DETROIT . . . Mar. 21, a distinguished panel of speakers gave us their ideas on Professionalism . . . Their talks were followed by a discussion session . . .

Professor Cecil C. Craig, University of Michigan, spoke first, followed by William Kohl, Allis-Chalmers Industries; James Barrabee, Hoover Ball and Bearing Co., and George Dowling, chief inspector, Machine Shop and Stamping Plant, Ford Motor Co., Windsor, Ont., Canada. The meeting was co-sponsored by the Windsor section, ASQC.

Two recent 24 hour courses which continued two presented earlier this season terminated with good attendance. Instructors were Raymond L. Clark, James Barabee, Morris Lighstone, Stephen Adams and Dr. George Haines.

Frances D. Huntington

EVANSVILLE-OWENSBORO . . . Mar. 21, Ladies' Night, plant tour of Arkla Manufacturing of Evansville, Ind. . . . Host for the tour of this large air conditioner manufacturing plant was Lou Fisher, QC manager of the Evansville production facility . . .

As this plant has been in this area for only three and one half years, we were amazed at some of the modern QC techniques employed in the manufacture of the large commercial units.

The guided tour was followed by refreshments. Highlight of the evening was the presentation of an outdoor gas light as the attendance prize to Mr. and Mrs. James Cherolis of Owensboro. These gas lights are a product of Arkla.

Wane E. VerWayne

GEORGIA . . . Mar. 30, the Georgia section held its fourth meeting of the fiscal year at the Wilby Room of the Price Gilbert Library, Georgia Institute of Technology . . .

Three talks were "Inventory of Yarn on Loom Beams" by E. G. Field of Atlanta; "Garment Manufacturers Experiences with Yarn Defects" by Richard A. Whitten of the William Carter Co., Barnesville, and "Uniformity Program for Better Yarns" by Jim Wheeler of Canton Cotton Mills, Canton.

E. G. Field

HAMILTON-MIDDLETOWN . . . June 3, the Hamilton-Middletown and Cincinnati sections will again have their joint annual dinner dance at the Greenhills Country Club in Greenhills, Ohio . . .

A cocktail hour from 7-8 p.m. will be followed by the presentation of the new officers of both sections and dinner served shortly after 8 p.m. Dancing will be from 9 p.m. to 1 a.m., with music by a ten-piece orchestra — the Seven Sharps — from Cincinnati, Ohio.

As in the past, we expect that this again will be a wonderful evening of fine food and good music. We anticipate the usual large attendance of joyful ASQC members and their partners.

Lon Ely

HAMILTON . . . Mar. 9, we listened with interest as M. J. McKerrow, section engineer, Canadian Westinghouse Co. Ltd., spoke on "Standardization and Quality Control — Partners in Cost Reduction" . . .

Mar. 21, the Quality Control Forum Committee met at Harding Carpets, Brantford, Ont. The progress reported on our plans for the Forum indicate that it will be bigger and better than ever. Only you can make this a certainty.

Oliver W. Holland

HARRISBURG . . . Mar. 1, the section members toured the Armstrong Cork Closure Plant, Lancaster, Pa. . . .

During the tour we were shown the various production lines for the manufacture of the crown cap for both beer and carbonated beverages; artmold jar closures; cork extrusion and the manufacture of the liners and spots for the caps, and lithographing presses.

It was very interesting, with the processes ranging from stamping operations, printing, extruding, gang slicing; metal cap dies performing blanking, curling, knurling and lining operations; forming thermoplastic and thermosetic plastic into beautiful and useful caps for cosmetics, liquer and medicine bottles, and the styron induction molding press operation.

Dinner followed at the Overlook Country Club with Dr. Carl E. Noble as guest speaker. His subject was "Administrative Applications of Quality Control."

He stressed the need to instruct the workers in the process they are trying to make and control and to stimulate an interest in better work and less absenteeism.

In order to maintain good market research, it is necessary for sound factoral survey based on good readings, practical methods and good judgment, said Dr. Noble.

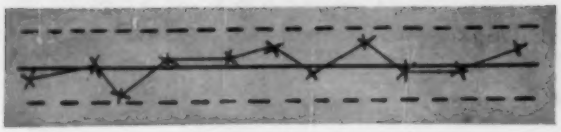
Ann Englehart

HARTFORD . . . Mar. 14, Paul Shuttleworth, Standard Pressed Steel, discussed "The Application of Work Sampling or Ratio Delay to the Control of Shop Quality". . .

The main difference between his approach and the usual Industrial Engineering application was that the speaker's sample was of parts rather than operators.

The samples are tabulated weekly and merged mathematically with past performance to develop a quality index for each department.

A film "The Search for Reliability" was shown at the meeting by Mr. Shuttleworth.



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Ken Martin is still looking for volunteers to assist the Hartford section in the task of presenting the 1961 New England QC Conference in October at Hartford, Conn. If you are interested, please contact Mr. Martin at Veeder-Root.

L. J. Sespaniak

HUNTSVILLE . . . Mar. 23, M. R. Seldon, chief, quality assurance department, Astronautics Division, Chance-Vought, spoke on "Industrial Applications of Military Reliability Programs" . . .

Mr. Seldon pointed out that very few industries use a program to guarantee their products.

Mr. Seldon concluded his presentation by adding that many industries have great stores of data which would enable them to predict reliability and would quite likely increase sales.

Officers of the Huntsville section met with officers of the Birmingham and Pensacola-Mobile sections to plan the annual Quality Control Conference which is sponsored by these sections in cooperation with the University of Alabama. The Conference will be held in October 1961.

Mar. 23, officers were nominated for the coming year.

Barry E. Davis

STATE UNIVERSITY OF IOWA . . . Mar. 31, Moline, Ill., Raymond Swenson, Illinois Institute of Technology, Chicago, Ill., demonstrated his experiences, by means of slides, in recently installing a new Quality Control Program in a midwest firm . . .

Inasmuch as the slides involved a heavy equipment firm manufacturing a product using processes similar to those used by many of the members' firms, the program was of special interest to the group.

E. B. Godsey

KANKAKEE-JOLIET . . . Mar. 7, the section met for dinner at the Maple Manor Restaurant in Kankakee and proceeded from there to a plant tour of the Simoniz Company of the same city . . .

Those who toured the plant received an assortment of products of consumer size, produced and/or packaged by this facility. Both the dinner and the tour were well attended.

The nominating committee, consisting of Miss Mary Egges, chairman; Garr Burt, Robert McKeague, Jr., Arley Wilson and Gerald Oliver, presented a slate of candidates for the election of section officers for the 1961-62 fiscal year. Ballots have been mailed to all members.

John E. Rauworth

KANSAS CITY . . . Mar. 16, the section was treated to an interesting presentation on "Organization and Administration of a Quality Program" by W. L. Lieberman, Armour and Co., Chicago, Ill. . . .

H. Afton Taylor

LEXINGTON . . . Mar. 16, Frank J. Sindelar, quality manager, Data Processing Division, IBM, spoke on "Management of Quality Control" . . . His presentation of the many factors affecting the quality organization in various industries and companies was most interesting.

June 17, Annual Dinner Dance, Lexington Signal Depot Officers' Open Mess . . .

James C. Graff

LIMA . . . Mar. 14, Westinghouse Corp., Lima, Ohio. 38 members and guests heard "An Engineer's View of Tolerance" by Charles H. Spurlock, standards engineer, Westinghouse Corp., Pittsburgh, Pa. . . .

E. K. Anderson

LOS ANGELES . . . Mar. 28, 357 members and guests attended Norair night . . . R. R. Nolan presented Norair's Management Philosophy on Quality and Reliability . . .

Mr. Nolan pointed out that the manager must look beyond the pure mechanics of any function to understand the human factors involved in creating the right operating philosophy and human motivation. Regardless of the theoretical soundness of any operating plan, it's the people who make it work or make it fail.

Joseph Rose, IBM Corp., illustrates his topic, "The Computer—An Easy To Use Tool for Statistical Quality Control," at the Philadelphia section technical session Mar. 16.

E. C. Bennett, chief of quality engineering, spoke on "Quality Control's Relationship to Design." Mr. Bennett said that many generally accept quality control's prime responsibility as the function of verifying product conformance to engineering specifications. There is, though, another QC responsibility, not so commonly understood, which involves those activities associated with conformance to design intent.

June 27, RCA will present a panel headed by H. J. Walters, manager, Product Assurance . . .

The spotlight speaker, A. N. Curtiss, manager, West Coast Division, will present "Management Views Reliability."

The guest speaker, C. M. Ryerson, Sr., product assurance administrator, will speak on "Prediction Techniques and Use of Reliability Handbooks in Relation to Failure Distribution and Test Methods."

With the fine work completed by RCA in their two published technical reports: TRI-100 and TR 59-416-1, this should prove to be a very interesting meeting.

Steve Kozich

LOS ANGELES—VALLEY SUBSECTION . . . Mar. 29, the Valley Subsection held the first meeting at Hody's Restaurant with 208 in attendance . . .

The meeting was very interesting with C. (Kelly) Johnson, engineering test pilot of the spy plane shot down over Russia, the U2. Johnson pointed out the increasing importance of the role of QC in the fabrication of supersonic aircraft and mach three transports.

Nick Chilikos

MEMPHIS . . . Mar. 14, Buckeye Cellulose Corporation as host provided delicious refreshments both before and after the program . . . Guest speaker was Richard S. Bingham, Jr., QC manager. Carborundum Co., Niagara Falls, New York . . .

Mr. Bingham told our section what to tell top management about statistical QC and how to go about it in his presentation "Ten Minutes with Top Management."

"The best thing to do is to show them rather than tell them," concluded Mr. Bingham.

June 20, Plough, Inc., will again play host to the section . . . The program will feature a movie on "Operations Research" and will be followed by a group discussion . . .

W. L. Dickerson

MID-HUDSON . . . Mar. 7, Hotel DiPrima, 38 members and nine guests present heard H. L. Freeman, QC engineer-consultant, General Electric Co. . . .

Mr. Freeman gave a very interesting talk on the basic concepts for organizing operating quality costs, how to use them as a guide for managerial decision-making and planning, and how to measure improvement in quality programs. A member of the Metropolitan section, ASQC, Mr. Freeman has spoken at several ASQC Conferences, both in the United States and Canada.

June 6, Annual Social Meeting featuring an outdoor barbecue at the Hotel DiPrima, Highland, N.Y. . . . An excellent menu has been prepared and entertainment is being planned . . .

E. L. Leadbitter

MILWAUKEE . . . Mar. 17, the Eighth Industrial Clinic for Quality Control included statistical training, metrology and general interest subjects . . .

Dr. Joseph Shea, director of advanced concepts, A.C. Spark Plug Division, General Motors Corp., gave the kickoff speech entitled "The Role of Quality in Military and Space System."

The program featured an outstanding list of speakers that included Dr. Gayle W. McElrath, who spoke on statistical techniques and their application in industry; C. R. Burdick with "Quality Control in Today's Changing Business Picture"; D. B. Tallon with "A Quality Control Program that Management Can Use"; Hy Pitt with "QC of Packaged Food Products"; Dr. Horace Andrews with "Statistical Techniques Used in EVOP"; Joseph Holland, Robert Brundle, and Udo Hilburt, who presented a program on gaging and metrology; and Charlie Hanson, Milwaukee radio personality, with a refreshing and entertaining after dinner speech spoofing the QC profession.

Judging from the comments of some of the 118 registrants who attended the sessions, the clinic committee felt that the clinic was an outstanding success this year.

Darrell Schroeder

MINNESOTA . . . Mar. 15, Dick Carlson, McCullough Corp., section secretary, presented "Minimum Sample Size Inspection" as worked out and used at McCullough Corp. . . .

Mr. Carlson stressed the cost expended by companies in an effort to get "better" OC curves rather than stressing the basic purpose of sampling which is to accept good and reject bad lots.

The plan, in short, is to increase the sample size to give our probability of acceptance and to keep the acceptance number at zero.

Mr. Carlson then went on to explain the procedure for setting up such a plan — the results in cost savings at McCullough, and the accuracy in detecting bad lots and the low number of good lots rejected.

All of this raised a lively discussion — pro and con — on the merits of the MSS plan *vs.* MIL-STD-105 tables. While many members disagree with Dick, at least we were all shaken out of the placid and perhaps dangerous attitude that MIL-STD-105 is the only and best plan available, and it left us with the thought that we could all take a closer look at our present set-up to check its efficiency cost-wise and quality-wise.

Violet M. Rice

MONTREAL . . . Mar. 8, Peter F. Wade, Price Waterhouse & Co. Ltd. of Montreal spoke on "The Statistical Approach to Subjective Methods of Testing and Evaluation" . . .

Methods of taste testing, visual examination and similar topics were covered. Examples were given of practical techniques used in the evaluation of surface defects of sheet metal.

Mr. Wade showed how limits can be applied to these general personal characteristics and the Quality Control principles involved.

Mar. 22, 95 members and guests met for dinner followed by a plant tour of Trans-Canada Air Lines new

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Keen interest was shown and questions "flew," especially in the Standards Room, the Non-Destructive Tests Room and the Quality Control Department, where a gamut of charts neatly represented good QC work.

June 14, a film, "Consumers Want to Know?" and a talk will be given by Morris Kaplan, technical director, Consumers Union, at our annual dinner meeting.

T. F. Waterston

GREATER MUSKEGON . . . Mar. 9, 42 members attended our annual social mixer and shrimp dinner at the Mona Lake Boat Club. The food was delicious and there was more than we could eat. Our entertainment centered around card games, pool tables, and the bar. We also enjoyed a three reel movie featuring W. C. Fields.

Officers for the 1961-62 calendar year are William Poe, chairman; Jack Fortenbacher, vice chairman; Robert Melton, secretary; Jack Bergsma, treasurer; William Hume, education; Albert Baker, publicity, and Elwood Presley, membership.

W. A. Hume

NORTHEAST TENNESSEE . . . Mar. 14, Tennessee Research Auditorium, Kingsport, Tenn., John Gross, Magnavox Co., Greenville, Tenn., conducted a pre-session clinic on "Marketing and Sales" . . . His talk was followed by dinner at the Tennessee Eastman Cafeteria.

The section was honored by the presence of J. Y. McClure, president, ASQC, and QC manager, Convair Division, General Dynamics Corp., Fort Worth, Texas. Mr. McClure gave an interesting talk entitled "Cutting Costs with Quality Control." The talk stressed the need for reduced costs through better QC management. Some very interesting case histories were used by Mr. McClure as examples.

J. T. Johnson, chairman, Northeast Tennessee section, greets J. Y. McClure, president, ASQC, in the lobby of Raytheon Manufacturing Co., Bristol, Tenn., during a recent visit to the section.

Attendance at the meeting was 61 members and 21 guests, with good attendance from students at Steed College and East Tennessee State College.

Mike Gomez

OMAHA-LINCOLN . . . Mar. 10, dinner meeting, Marchio's Steak House, Omaha, Nebr. . . .

Report of the nominating committee was heard and adopted. The program was an excellent plant tour of the Continental Can Co., Omaha, Nebr.

T. C. Anker

ORANGE EMPIRE . . . Mar. 16-17, Western Regional Conference, Anaheim, Calif., sponsored jointly by Orange Empire and Los Angeles section . . .

The Plenary session was conducted by general chairman Dr. Harry G. Romig, who introduced Mayor A. J. Schutte of Anaheim, J. Y. McClure, president, ASQC, and Captain W. A. Hassler, Jr., U.S. Navy, who addressed the session on "Polaris Highlights."

S. "Sy" Bushler, section chairman, and E. J. "Jack" Lancaster, chairman, Los Angeles section, and Dr. Harry S. Romig, chairman, 1961 Western Regional Conference, and conference officers, committee chairmen, and their assistants are to be congratulated for a very interesting, educational and entertaining Conference which featured 70 recognized authorities in their respective fields. A five point program was presented which stressed reliability, inspection workshops, process control, statistics, and tests.

Mrs. Eleanor Hurst was hostess of the Ladies' Program which included visits to Disneyland, Marineland, Knotts Berry Farm and the Balboa Bay Club.

Henry W. McKee

PARKERSBURG . . . Mar. 15, tour of computer installation, Bureau of Public Debt., attended by 20 members — very interesting as the installation is modern in every detail . . .

Robert R. Stewart

PENSACOLA-MOBILE . . . Mar. 16, Dr. Edwin F. Moore presented "The Role of QC in Development" . . .

"Quality Control just isn't inspection in accordance with a drawing or specification," Dr. Moore said. "Unfortunately, many people in QC have this concept."

He then proceeded to delineate those functions that should be performed by the QC department during the development of a product. As chief of the quality analysis section, Solid Propulsion Operation, Rocketdyne Division, North American Aviation, we are sure that what Mr. Moore said was in the realm of the practicioner rather than the theorist.

Walter D. Nencka

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Frequency Response from Stationery Noise: Two Case Histories, N. R. GOODMAN, S. KATZ, B. H. KRAMER and M. T. KUO
The Modified Gauss-Newton Method for the Fitting of Non-Linear Regression Functions by Least Squares, H. O. HARTLEY
On the Possibilities of Improving the Mean Useful Life of Items by Eliminating Those With Short Lives, G. S. WATSON and W. R. WELLS
The Optimum Allocation of Spare Components in System, DONALD F. MORRISON
Use of Tables of Percentage Points of Range and Studentized Range, H. LEON HARTER

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WHY NOT SEND YOURS IN TODAY?

PHILADELPHIA . . . Mar. 16, Arnold Hayes, vice president, Clifton Precision Products Co. Inc., delivered a timely talk on "The Quality Demands of Space Technology" at the dinner meeting . . .

He dwelled on some very interesting facts and philosophies relative to the space program.

To demonstrate the need for writing specifications accurately and with complete understanding, he gave some amusing examples of words having different meanings depending upon their application and interpretation.

The increasingly popular technical sessions were covered by Burton Cushner of IRC and Joseph Rose of IBM Corp. Mr. Cushner enlightened the group with the technique of "QC Waiting Line Theory" and distributed papers with problems and solutions.

Mr. Rose also distributed an informative booklet to supplement his talk on "The Computer — An Easy to Use Tool for SQC."

As a follow-up to this presentation, Mr. Rose extended an invitation to ASQC members to attend a demonstration of the effectiveness of computers in solving QC problems at the new IBM Data Control Center at Penn Center, Philadelphia, Pa.

Albert G. Dettore

PITTSBURGH . . . Mar. 28, at the last minute the previously scheduled plant tour of the Jones & Laughlin Steel Corporation had to be cancelled . . .

In its place, a panel discussion of "The Management of a Quality Control Function" was scheduled. Four areas discussed were receiving material control; process control and feedback; final inspection and quality assurance, and quality engineering. The discussion was followed by a lively question session, and all attendees were well rewarded by a most informative session.

Our section has launched a program for participating with the Pittsburgh Council for International Visitors. The object of the program is to provide dinner, overnight facilities or just a guided tour of Pittsburgh to international visitors of the area.

Plans are underway to formulate the 1961-62 programs. Suggestions solicited from members will be incorporated in this program.

The section has not scheduled a meeting for June. Instead, we are hopeful for a large turnout at the ASQC Convention and Exhibit.

Chester R. Smith

PITTSFIELD . . . Mar. 16, the executive committee held an open meeting at the Stanley Club in order to hear comments from the membership on bylaws as proposed by ASQC . . . The bylaws were accepted with one small exception and the secretary was instructed to return them with the deviation noted . . .

Mar. 21, our regular monthly meeting was held at the Stanley Club with Dr. Richard O. Rouse, Jr., as guest speaker . . . Dr. Rouse is Associate Professor of Psychology at Williams College in Williamstown, Mass.

His topic was "The Psychological Basis for Decision Making." If your mind is confronted with a problem, it will use a definite pattern in attempting a solution. As much as we hate to admit it, a monkey or chimp uses the same pattern. This proves the reaction is a basic one.

Toward the end of the talk, Dr. Rouse gave us a test which proved his theory to be correct.

This was a joint meeting with representatives of several engineering groups.

Howard J. Greenslet

PORTLAND . . . Members enjoyed a plant tour of Willamette Iron and Steel Co., where they saw the unusually large testing equipment necessary in this company's business . . . AIEE members at Willamette led the plant tour . . .

Henry Blood of Omark Industries, Inc., will attend the ASQC Annual Convention and Exhibit in Philadelphia, Pa. He is taking with him letters from the Chamber of Commerce and other civic groups inviting

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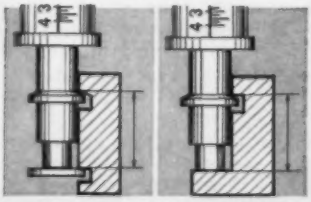

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the ASQC to schedule some future convention in Portland, Oregon.

June 9, a gala time is being planned by co-chairmen Ruth Jones and Pat Keyes for members and their wives . . . The program at the Ho-Ti Supper Club will start with cocktails at 7 p.m. and dinner at 8 p.m., followed by a short business meeting . . . At the end of the meeting, there will be a floor show and dancing . . .

George Mickel

RACINE . . . Mar. 16, E. J. Fortenbacher, QC manager, Standard Automotive Parts Co., Muskegon, Mich., presented a talk on "Process Control in a Centrifugal Casting Foundry" . . .

Using 35 mm slides, he illustrated a process for centrifugally casting and semi-machining grey iron cylinder liners for the engine industry. By means of an opaque projector, he demonstrated the use of control charts in measuring product quality.

The 37 members and guests who attended the dinner meeting represented the second largest turnout of the year despite stiff competition from the Patterson-Johanson fight.

Frank Milauc

RADFORD-ROANOKE . . . Mar. 28, 30 members heard David Chambers, executive secretary, ASQC, present a very interesting program on Quality Control in the Textile Industry at Grant's Tavern, Christiansburg, Va.

May 23, plant tour, Celanese Corp., Narrows, Va. . . .

June 24, section picnic, the last event until September.

J. F. LaRocco

RHODE ISLAND . . . Mar. 16, a full house listened to Edward M. Schrock define management's guide posts for measuring the effectiveness of a quality program . . .

June 1, the education committee will finish the year with the presentation of quality control certificates to 20 enrollees with the Extension Division, University of Rhode Island . . . These students successfully completed two 15-week courses in basic and advanced quality control taught by the Rhode Island section members Joe Kowalski and Casmiro Antonio . . .

Paul K. Moffat

ST. CHARLES . . . Mar. 21, Tally-Ho Restaurant near West Chicago, a talk on "Communications," given by Ivan Reinhart, General Electric Co., was well received . . . Through many years of factory experience, Mr. Reinhart certainly was aware of the serious need for good communication in any manufacturer's plant . . . Through demonstration, Mr. Reinhart showed how unreliable verbal relaying of information can be . . .

Mar. 25, the first all day workshop held in cooperation with the Aurora College, Aurora, Ill., was an outstanding success . . .

While it was the first adventure into such an affair, the day was well planned and the workshop was executed as if everyone was well experienced with such conferences.

Early planning was done on the basis of 100 participants. However, advance registration was well over 200 before the day of the workshop. This required last minute switches of classrooms to accommodate the increased attendance as well as to provide additional luncheon facilities.

The day was divided into three periods, and each period offered four choices of topics — inspection technique; communication, and inspection measuring and testing devices. In addition to these periods, a luncheon was served in the Aurora College Cafeteria and an address was presented by Paul Ely, market research manager, Bell and Howell Co., Chicago, Ill.

Judging from the interest shown in this first adventure by our section, it is fairly certain that more will follow.

Ellis Elder

ST. LOUIS . . . Mar. 17, H. Mack Truax, Atlas Powder, was unable to be in St. Louis for the March meeting . . . We were fortunate in being able to obtain L. T. "Jack" Lanz, training director, J. F. Queeny plant, Monsanto Corp., to speak on "Selling Quality Control." His talk was well received by the 21 members and 12 guests in attendance . . .

David Chambers, left, executive secretary, ASQC, presents the section charter to chairman of the new Radford-Roanoke section, R. C. Rhodes, right, Hercules Powder Co.

Harry Hehner presided over a symposium on Evolutionary Operation held in March during the 139th National Meeting of the American Chemical Society. The following papers were presented by St. Louis section members: "Introduction to EVOP" by R. C. Manring and W. W. Paris, and "EVOP Training" by E. H. Barnett.

W. W. Paris

ST. PETERSBURG-TAMPA . . . Mar. 13, the Ladies' Night meeting, in spite of inclement weather, turned out to be a very interesting evening as some 45 members and guests attended the dinner meeting . . .

R. J. Livingston of Earl J. Small's Orchards and Sheriff Don Genung presented entertaining talks as evidenced by the comments expressed by those in attendance.

The election of officers for the 1961-62 season was held and the following members were elected: chairman —Cal Wyatt, General Electric Co.; vice chairman — Walk Beers, General Electric Co.; secretary — Joe McGuirk, ECI, and treasurer — Harold Goldberg, ECI.

A six week training course which meets two hours a week began Mar. 27 with 30 students.

Harold L. Goldberg

SAN ANTONIO . . . The feature speaker for the March meeting held at DeWinnies Belgium Inn was Dr. R. C. McMasters, Ohio State University, who presented "Non-Destructive Testing's Role in Quality Control" . . .

Dr. McMasters, a well known authority in the NDT field, kept the audience in complete enthusiasm throughout his presentation.

We were honored to have Mrs. McMasters and their daughter among those in attendance for this Ladies' Night dinner meeting which was attended by 25 members and guests.

June 20, the section is anxiously awaiting the annual family picnic and dance and installation of officers at the Lone Star Brewery picnic area . . .

R. W. Worrick

SAN BERNARDINO . . . Mar. 29, R. Sanchez proved an able substitute for Russ Medlock, who was unable to speak for the scheduled monthly meeting . . .

Mr. Sanchez, who is supervisor, product support group, Convair Astronautics, gave a historical resume of the development of the Atlas Missile Program at Convair with emphasis on the reliability aspects.

June 21, the two winning papers of the annual technical paper contest will be presented by the authors at

our June meeting . . . This is our fifth annual technical paper contest . . . Papers which have been submitted are uniformly of high caliber and are a clear indication of the increasing professional level of our section membership . . .

Members enter in one of two categories — professional author's class for those who have previously published papers, and novice class for amateurs. Winning papers will be submitted to the editorial board of IQC for possible publication.

Gene A. Williams

SAN DIEGO . . . Everyone in the section continues to be very proud of the attendance at our monthly meetings. Throughout the year this section's meeting attendance has never fallen below a figure equaling 70 percent of the section's membership. Our March meeting attendance was a gratifying 90 percent of our membership figure.

This March meeting was directed toward the junior offspring of our members. The guest speaker, Dr. J. Ryan, Space Medicine, Convair Astronautics, held the undivided attention of young and old alike as he let the juniors establish the program for the evening.

The entire evening was refreshingly unique in that Dr. Ryan had no specific subject prepared for the presentation. Rather than resort to a prepared talk, Dr. Ryan asked the juniors in the audience for subjects upon which they would like to hear short discourses. Toward the end of the evening, Dr. Ryan answered questions as presented by the juniors.

The caliber of questions asked has resulted in this reporter dispelling all fear for the technological future of our country.

As the San Diego area is becoming more and more engrossed in electric component and systems manufacturing, it is anticipated that another large attendance will be on hand to hear F. G. Ball, test equipment manager, Torrance Division, Ryan Aeronautical Co., speak on "Design, Manufacture, and Operation of Electronic Test Equipment" . . .

L. I. Fredrickson

SAN FRANCISCO . . . The March meeting was addressed by James L. Coburn, quality assurance manager, Lockheed Aircraft Corp., and a Fellow, ASQC. He reviewed his career in quality control activity in the areas of management, engineering, procurement and accounting. In addition, Mr. Coburn commented on the future of the profession, primarily for the benefit of the younger engineers who have recently formed QC organizations.

June 12, the Annual Meeting will be held at the Villa Hotel in San Mateo for members and their wives . . .

Dr. Grant Ireson, executive head of the Department of Industrial Engineering, Stanford University, will discuss his experiences last summer in Europe, where he provided technical assistance to industry and education. He will comment on some of the reactions observed and will relate economic developments in Europe to the nature of the peoples, as well as on the impact of the United States as a world power.

M. R. Hubbard

SEATTLE . . . Berl Owens, associate professor of mechanical engineering at the University of Washington and a member of the Seattle section, ASQC, is teaching in Yugoslavia for the current school year. Under a USOM grant for Industrial Education, he is teaching statistical QC and methods analysis to graduate engineers of the University of Belgrade and establishing a curriculum for a graduate program in Industrial Engineering. He has indicated in letters that although the students have a limited industrial background, they are eager to learn. According to Mr. Owens, the venture, along with a study of Yugoslavian manufacturing methods, is a rewarding experience.

D. C. Lillis

SOUTH TEXAS . . . The section has contributed $200 to the C. T. Shewell Library fund. Seventeen chemists and engineers have registered for the second semester course in engineering statistics, production engineering statistics, sponsored by Delmar College in Corpus Christi, Texas.

Ed Franklin

SOUTHERN CONNECTICUT . . . Mar. 3, despite snow and sleet, the section had a large turnout for "Receiving Inspection and Vendor Relations" by Frank Caplan, Jr., Westinghouse Corp., at the Bryant Electric Co., Bridgeport, Conn. . . . Many thanks for a job well done . . .

Mar. 18, the section held its Annual Seminar at the University of Bridgeport, Bridgeport, Conn. . . . The seminar was entitled "New Frontiers in Reliability and Quality Control Through True Positional Tolerancing and Process Control" . . .

Seminar leaders were Edward S. Roth, Sandia Corp., Albuquerque, N.M.; William Hay, Pipe Machinery Co., Wickliffe, Ohio, and E. F. Taylor, Glen L. Martin Co., Baltimore, Md. The seminar was well attended.

William E. Wells

SOUTHERN ILLINOIS . . . Mar. 16, the section held a meeting at the Herrin Coffee Shop, Herrin, Ill. . . . After the regular business meeting, presided over by C. A. Statler, chairman, and Virgil Wimmer, vice chairman, we enjoyed two entertaining movies, one on forgings in closed dies, and the other on the 1959 Chicago Cardinals Highlights . . .

During the meeting the subject for discussion was SIU's success in offering a course in QC. The first class consisted of 14 adults. The class was among the adult education courses offered by SIU. Quality Control will become a part of SIU's curriculum during the next term.

C. O. Touchon, Sr.

SYRACUSE . . . A four-session Quality Control Seminar was conducted by Bill Young, Dick Brown and George Endrich for the Industrial Management Club of Syracuse at the YMCA on Mar. 1, 8, 15, and 22.

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Jerry Reinertson, Jerrico Inc., conducts a demonstration for speakers, university people and members of the St. Charles section. From the left, they are Paul Ely, market research manager, Bell and Howell; Dr. Crimi, Dean of Aurora College; Albert Stoltz, chairman, St. Charles section, ASQC; Mr. Reinertson; Ralph Von Osinski, general chairman of the Mar. 25 All Day Workshop; Theodore Krueger, director of quality, Zenith Corp., and Mark H. Trumbo, professor of economics, Aurora College.

Mar. 21, J. L. Bernik, Martin Co., Baltimore, Md., gave an excellent presentation that was very well received by the membership and was particularly interesting to our student guests . . .

L. E. Huyler

TOLEDO . . . Mar. 2, at our dinner meeting at the Engineering Societies of Toledo Club Rooms, Dr. Brant Bonner, laboratory supervisor of industrial statistics, Dow Chemical Co., Midland, Mich., was introduced by Nelson G. Meagley, moderator for the evening . . . Dr. Bonner had a very attentive and interested audience for the development of his subject "EVOP in Industry".

Carwin L. Elwick

TRENTON . . . Mar. 23, "Blueprint for a Successful Quality Control Program" was presented by Stanley Wirtschafter, United States Gauge, Sellersville, Pa., before a capacity crowd . . .

Julius S. Mazakis

TUCSON . . . Fred Ennerson, Jr., section education chairman, has been conducting classes for Engineering Seniors at the University of Arizona for the past three years. The classes average 25 students and are conducted on Monday, Wednesday, and Friday. They cover engineering statistics and quality control.

Several of the students that have been graduated are now holding quality control positions in various companies.

At the recent ASQC Western Regional Conference, Anaheim, Calif., Mr. Ennerson presented "The Tolerance Buildup Story and How to Make Use of It in Troubleshooting Techniques."

Hughie W. Shea

UTICA . . . Mar. 16, the regular monthly meeting was held at the South Utica Post of the American Legion . . .

A roast beef dinner was enjoyed and well attended by section members. Featured speaker of the evening was James Barrabee, chief QC engineer, Hoover Ball and Bearing Co., Ann Arbor, Mich. His topic, "Planning and Quality Control Success," was well presented.

Hoover Ball and Bearing is apparently enjoying the fruits of a sound, well planned, QC program in which employees, measuring and evaluating their own work, provide and maintain the heart of the program.

Mr. Barrabee described the planning, analysis of work units, management and operator training program, inspection procedure planning, statistical quality control planning and implementation thru punched card collection of scrap and rework cost levels to obtain their QC program.

D. F. Yeaton

WASHINGTON, D.C. . . . Mar. 15, "Training for Quality Control" was discussed in great detail by a panel of noted personalities in the field . . .

Dr. Harold Bright, George Washington University, discussed University programs and efforts that are being made to adequately prepare good people for QC.

William MacCrehan, Bendix Aviation, discussed and illustrated with the aid of slides how QC is being taught to engineers and management representatives in industry.

Representing government, John Riordan, Department of Defense, stressed strong academic preparation for positions in QC as opposed to plant or factory training programs. It was generally agreed that good QC people are hard to come by, hence they had to be made from people with backgrounds in the physical sciences.

Richmond, Va., was very well represented among the visitors at this informative meeting.

Eugene Tucker

WESTERN MASSACHUSETTS . . . Mar. 14, H. L. Freeman, engineering service, General Electric Co., New York, N.Y., presented "Measurements and Quality Costs," which concerned the controls on quality and the associated costs for assuring product quality, expressing in dollars and cents the firm's performance . . . Also, through the use of such cost indicators, managerial planning can be performed more effectively by better use of available resources . . .

The meeting was well attended and the talk, followed by a question and answer session, was very interesting.

Henry D. Johnston, president, Strathmore Paper Co., West Springfield, Mass., acted as host for the evening and introduced the speaker.

In connection with Mr. Johnston's appearance, a display of paper products manufactured by the Strathmore Paper Company was on exhibition, and all members and guests attending the meeting received complimentary boxes of note paper — one of the company's products.

Alan J. Donnelly

WICHITA . . . Mar. 7, due to unexpected company commitments, Paul Hill, who was to be our March speaker, was unable to be here . . . We were very fortunate in obtaining Paul E. Allen, manager, spare parts sales and customer service, Beech Aircraft Corp., who spoke to us on "Quality Control in the Eyes of Management" . . .

Everyone present was convinced that he is a manager of his own affairs and we all must think of managing the quality of our way of life and of our work in accordance with our standing in our various companies.

June 6, an interesting meeting is anticipated with "New Horizons in the Space Age" by R. Harvey Anselm, manager of Missile Engineering, Beech Aircraft Corp. . . . Mr. Anselm, an accomplished speaker, is a member of the American Rocket Society . . .

H. K. Mitchell

WORCESTER . . . Mar. 21, joint dinner meeting with the American Institute of Industrial Engineers at Worcester Polytechnic Institute . . . A large turnout heard an interesting discussion on Quality Control for Industrial Engineering . . . LeRoy H. Lindgren, vice president of sales and engineering, Relco Corp., discussed, from a statistical approach, the use of a Quality Index to measure the effectiveness of an incentive plan as a tool of management . . .

Francis B. Olsen, New England district representative, ASQC, spoke on "Professionalism in the ASQC."

In addition to the above program, a movie "The Search for Reliability" was shown to explain the need for reliability in modern industry.

Daniel J. Burda

YOUNGSTOWN . . . Mar. 2, Dale A. Cue, quality manager, Hoover Ball and Bearing Co., Ann Arbor, Mich., discussed "Some Frustrations and Difficulties in Applying the Total Quality Control Concept" . . .

Mr. Cue said that the total quality control concept is one that places its major emphasis on new design control, planning for quality, getting into the act of analyzing the product and process earlier, and endeavors to remove the shackles of performing only the QC job which was confined to the "within plant" situation.

Charles T. Wirebaugh

Significant Differences

. . . AKRON-CANTON—**Robert W. Baker,** Timken Roller Bearing Co., has completed his course of study at Tri-State College, and has been awarded his Engineering Technician's Certificate.

. . . ALLENTOWN-BETHLEHEM—**Bonnie Small** and **Ken Stephens,** Western Electric Co., Allentown, Pa., working with **Dr. Ellis Ott,** Rutgers • The State University, planned and conducted the educational sessions at the 11th Annual Conference on QC in the Textile Industry Feb. 16-17. The Conference was sponsored by the Textile and Needle Trades Division, ASQC, and was held at the Robert Lee Hotel, Winston-Salem, N.C.

Irv Yeager spoke on the Basic Concepts of QC at the organizational meeting of the Hazelton, Pa., section, ASQC, on Feb. 22. Mr. Yeager and Mr. Stephens, Western Electric Co., Allentown, Pa., attended the Reliability Symposium at Vanderbilt University, Nashville, Tenn., Feb. 28 to Mar. 2.

. . . CHICAGO—CALUMET SUBSECTION—**Harold Williams,** supervisor of statistics, Inland Steel Co., has moved to a West Coast aircraft firm.

John Hromi, Gary Works, United States Steel, has been placed in charge of operations analysis for the entire plant. Mr. Hromi was acting chief of the mathematics division of the Applied Research Laboratory, U. S. Steel Corp., Monroesville, Pa.

Professor **Nicholas Relich,** formerly associate professor in physical science, is now associate professor in mathematics and statistics at Purdue University, Calumet Center, Hammond, Ind. Professor Relich will also aid the U. S. Steel Corporation's advanced technical studies program for supervisory personnel in the Chicago area.

. . . CLEVELAND—Congratulations to **Samuel H. Troxel, Jr.,** who has just been transferred to the executive staff of Ohio Bell Telephone Co., where he will be in charge of a new Operations Research group. Replacing Mr. Troxel as supervisor of statistics, sampling applications, is **J. E. Bechtold.**

. . . DALLAS-FORT WORTH—We were happy to have our former member and section director **Bill Smith** attend our Sixth Annual Symposium. He had recently left Chance-Vought to accept a position in California.

. . . EVANSVILLE-OWENSBORO—The section is beginning a program of inviting the engineering students of Evansville College to become student members. We feel that this program will help many future engineers to become better acquainted with the techniques being used in quality control.

. . . HAMILTON-MIDDLETOWN—Two door prizes were again given at the Mar. 1 meeting at the Sports Bowl, Middletown. A travel kit was won by **Charles Weaver,** and **Charles Hayes** received a manicure set.

. . . HARRISBURG—New officers for the 1961-62 season elected during the March meeting are chairman—**H. Gross,** RCA, Lancaster; vice chairman—**O. Fox,** Borg-Warner, York; secretary—**J. Fasnacht,** Hamilton Watch Co., Lancaster, and treasurer—**R. Lehman,** Carlisle Tire and Rubber Co., Carlisle.

We were pleased to welcome the following Allentown-Bethlehem section members as guests at the Mar. 11 meeting: **W. R. Moyer, R. Yeager,** Parish Pressed Steel Co., Reading, Pa., and **C. Divine,** Divine & Heffener Machine Co., Reading, Pa.

Herman Singer, education committee chairman, is busy finishing reports on three courses which have been completed during March.

. . . HARTFORD—**Tony Manzi** is now QC manager at Precision Industries. The firm name was changed from Skinner Chuck Co., New Britain, Conn.

Marty Keston has been promoted to assistant plant manager from general foreman at Dynamic Controls Corp., East Hartford, Conn.

. . . STATE UNIVERSITY OF IOWA—**Mike Wilson,** section secretary-treasurer, is now director of product assurance, Collins Radio Co.

Elmer Stambaugh is now QC director, Cedar Rapids Division, Collins Radio Co.

. . . LIMA—**George W. Vaught,** QC manager, Cooper Tire and Rubber Co., Findlay, Ohio, recently transferred to the Findlay Company and is now a member of the Lima section, ASQC.

. . . LOS ANGELES—The Los Angeles section has added 264 new members through Mar. 31. This total of 264 exceeds the total membership of all except eight sections of the Society and exceeds new members added by any section of the Society by approximately 100 new members.

Norair Night attracted more than 100 sub-contractors to the regular monthly meeting of the Los Angeles section.

. . . LOS ANGELES—VALLEY SUBSECTION—The Valley subsection attendance of 208 for the first meeting shows the great interest and industrial growth of the San Fernando Valley.

Jeff Barnes and **Ben Cogan** are on a committee which has been established to select an appropriate name for the new subsection.

The Valley subsection signed-up 21 new members at its first meeting.

. . . MID-HUDSON—**M. V. Morreale** and **C. L. Potter,** QC Division, Poughkeepsie plant, IBM, have been advanced to project engineers.

. . . MINNESOTA—**W. J. Dougherty,** Armour and Co., presented a paper on "Statistical QC in Food Processing" at a Technical Symposium conducted by the Twin City section, AIChE, in Minneapolis.

. . . MONTREAL—Four section members who were active as speakers and moderators at the Toronto All Day Forum in March are **D. J. Harrison,** Professor **R. Lessard, J. B. Pringle** and **C. I. Taylor.**

New directors are **Gregg Belcher,** Canadian International Paper Co.; **John J. Fitzsimmons,** Canadian Marconi Co., and **Donald M. Park,** Steel Company of Canada.

Officers for 1961-62 are chairman—**W. L. Wingfield,** Trans-Canada Airlines; vice chairman—**S. B. Thomas,** Northern Electric Co. Ltd., and secretary-treasurer—**T. F. Waterston,** Canadian Marconi Co.

. . . NORTHEAST TENNESSEE—The second annual QC Clinic at the University of Tennessee in Knoxville, Tenn., Mar. 17-18, was a marked success. Seventeen ASQC members and 104 guests attended.

A graduate course in statistics presented by East Tennessee College was successfully completed by **J. T.**

Johnston, section chairman; **C. E. Stone,** section treasurer, **Jim Harr,** section member, and **Houston Campbell,** membership chairman.

Mr. Johnston, section chairman, spoke to the Kiwanis Club Mar. 23. His topic—"Looking Ahead in Missiles and Space Explorations."

. . . OMAHA-LINCOLN—**John J. Pappas,** Omaha, Nebr., has been appointed associate program chairman. He will assume chairmanship July 1.

. . . ORANGE EMPIRE—**"Cy" Bushler,** formerly with Hughes Semiconductor Division, is now production manager of Heliotic Corp.

Al Candelaria, formerly QC manager, Custom Systems Corp., is now chief of QC at the Norden Co., a Division of United Aircraft.

Ed Murachver has transferred from quality engineering to sales liaison at Hughes Semiconductor.

Fred Peck, past chairman, Orange Empire section, ASQC, is now QC director, Data Tape Division, Consolidated Electro Dynamics, Pasadena, Calif.

. . . PHILADELPHIA—**James Wilkes** has been appointed manager of reliability and quality control, Documented Reliability Department, International Resistance Co. This department is currently in full-scale production of high reliability fixed metal film resistors for the Minuteman missile as well as for other military applications. Mr. Wilkes, who has been with IRC since 1950, was most recently QC manager for the firm's Philadelphia division. He is succeeded in that position by **Burton Cushner,** formerly division supervisor of process control. Mr. Cushner joined IRC in 1952.

. . . RHODE ISLAND—**John Pollard,** chief QC engineer, Texas Instruments Inc., M & C Nuclear Products Group, led a recent American Management Association Seminar "Organization and Management of the QC Function," Mar. 15-17, at the LaSalle Hotel, Chicago, Ill.

Neil MacLaren, QC director, Brown & Sharpe Manufacturing Co., spoke to the Society for Advancement of Management in Providence, R.I., on Mar. 30. The topic—"Quality Control in the Machine Tool Industry."

. . . ROCHESTER—**Raymond F. Jacque** has been appointed manager of quality assurance in the Military Products Division, General Dynamics/Electronics. In this position Mr. Jacque will have full responsibility for all QC activities in the Military Products Division. Prior to this assignment he was assistant manager of QC in the division for seven years. Earlier, since joining the company in 1950, he had been a design engineer, test engineer, and chief inspector.

. . . ST. CHARLES—**Ted Krueger** has been named general chairman of the annual Management seminar to be held in late summer.

. . . ST. PETERSBURG-TAMPA—**Charles D. French,** Pinrelas Peninsular plant, General Electric Co., has been appointed general foreman, inspection and test. Mr. French is a senior member, ASQC.

. . . SAN FRANCISCO—**Roy A. Wylie,** formerly with Ampex, has joined Lockheed Missiles and Space Division as supervisor of research quality assurance and test services.

Arthur Brown of Friden, Inc., has been promoted to supervisor of quality control.

. . . SOUTH TEXAS—**George B. (Bob) Deakin,** recently of Celanese Corp., Corpus Christi, Texas, has been transferred to the QC department, Narrows, Va., Celanese plant.

. . . WACO—**F. E. Craig** and **H. G. Boyd** have joined Rocketdyne as quality control analysts.

. . . WICHITA—Interest in Society activities is remaining at a high level in spite of the lay-offs and employment adjustments that are occurring in Wichita. Several of our members have recently transferred from QC to engineering, sales, *etc.*

Short Courses in Quality Control

Usual Time Course is Held	*Type of Course*	*Where Held*	*Course Director*
February	Basic	University of Illinois, Urbana, Ill.	John A. Henry
April	Advanced	University of Connecticut, Storrs, Conn.	Richard M. Story, Jr.
May	Basic (Textile Ind)	North Carolina State College, Raleigh, N.C.	David B. Stansel
June 5-9	Basic (Graphic Arts)	Rochester Institute of Technology, Rochester, N.Y.	Harold Kentner
June 7-17	Design of Experiments	Purdue University, Lafayette, Ind.	Charles R. Hicks
June 11-23	Reliability Institute	University of Connecticut, Storrs, Conn.	Richard M. Story, Jr.
June 12-21	Basic (Chem. Ind)	Rochester Institute of Technology, Rochester, N.Y.	Harold Kentner
June 19-30	Basic	TAPPI Statistics Course, Queens University, Kingston, Ontario, Canada	.....
June 19-30	Advanced	TAPPI Statistics Course, Queens University, Kingston, Ontario, Canada	.....
June 22-29	Advanced (Chem. Ind.)	Rochester Institute of Technology, Rochester, N.Y.	Harold Kentner
July 31-Aug. 11	Statistical Methods In Industry	UCLA, Los Angeles, Calif.	Edward P. Coleman
August 21-31	Basic	University of Michigan, Ann Arbor, Mich.	C. C. Craig
September 5-15	Advanced	Purdue University, Lafayette, Ind.	Irving W. Burr
September 10-22	Basic	University of Connecticut, Storrs, Conn.	Richard M. Story, Jr.

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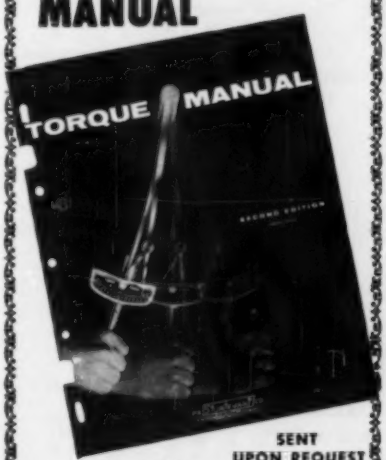

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SECTION CALENDAR (JUNE 1 TO JULY 10)

SECTION	DATE	PLACE	TIME	SUBJECT	SPEAKER
Albany	June 1	Hot Shoppe	4:30 p.m.	V Notch Control System	D. S. Holmes, General Electric Co., Schenectady, N.Y.
Akron-Canton	June 15	Firestone Tire	7:30	.....	.....
Allentown-Bethlehem	June 21	Hotel Traylor	6:30	Ladies' Night, Statistical Aspects of the Discovery of Oil	Robert Staley, Western Electric Co., Allentown, Pa.
Corning-Elmira	June 17	To be announced	....	Picnic	.....
Dayton	June 8	To be announced	6:30	Picnic	.....
Greater Detroit	June 24	To be announced	....	Annual Golf Day	.....
Evansville-Owensboro	June 13	Evansville	6:30	Installation of Officers	Jim Romerhausen, section chairman
Hamilton-Middletown	June 3	Greenhills Country Club Greenhills, Ohio	7:00	Annual Dinner Dance	Seven Sharps Orchestra, Cincinnati, Ohio
Harrisburg	June 7	Mt. Joy	6:30	Picnic, Installation of Officers	.....
Kansas City	June 15	19 E. Armour Blvd.	8:00	Report of Annual Convention	.....
Lexington	June 17	Lexington Signal Depot	7:00	Annual Dinner Dance	.....
Los Angeles	June 27	IAS Bldg.	7:00	RCA Panel	C. M. Ryerson, RCA
Memphis	June 20	Plough, Inc.	8:00	Movie — Operations Research	.....
Mid-Hudson	June 6	Hotel DiPrima	....	Social Meeting	.....
Montreal	June 14	Queen's Hotel, Montreal	6:30	Annual Dinner Meeting, Consumers Want to Know	Morris Kaplan, Consumers Union, Mount Vernon, N.Y.
Omaha-Lincoln	June 9	Marchio's, Omaha	7:00	Ladies' Night	Mel Crabill, Health Department, Omaha-Douglas County
Orange Empire	June 20	Anaheim Bowl, Anaheim, Calif.	7:30	Philosophy, Policy, and Goals of the ASQC at Society Organization Level	J. Y. McClure, president, ASQC
Philadelphia	June 5-7	Sheraton Hotel	....	Annual Convention and Exhibit	Several
Pittsfield	June 17	Oak'n Spruce, Lee, Mass.	....	Picnic	.....
Portland	June 9	Ho-Ti Supper Club	7:00	Dinner Meeting	.....
Radford-Roanoke	June 24	To be announced	....	Picnic	.....
St. Petersburg-Tampa	June 12	St. Petersburg Junior College	8:00	How to Present Your Proposal	Harry S. Gunther, Electronic Communications, Inc., St. Petersburg, Fla.
San Antonio	June 20	Lone Star Brewery Picnic Area	6:30	Picnic and Installation of Officers	.....
San Bernardino	June 21	Mural House, Ontario, Calif.	7:00	Presentation of Winning Contest Papers	To be announced
San Diego	June 12	Sands Hotel, Clairmont Mesa Blvd., Highway 395	7:00	Design, Manufacture and Operation of Electronic Test Equipment	F. G. Ball, Torrance Division, Ryan Aeronautical Co.
San Francisco	June 12	Villa Hotel, San Mateo, Calif.	7:00	The Ugly American in Europe	Dr. Grant Ireson, Stanford University, Palo Alto, Calif.
Seattle	June 16	To be announced	....	Dinner Dance and Installation of Officers	.....
Syracuse	June 20	Turners	6:30	Social Evening	.....
Wichita	June 6	Wichita University, Campus Activity Center	6:30	New Horizons in the Space Age	R. Harvey Anselm, Missile Engineering, Beech Aircraft Corp.

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(as of March 31, 1961)

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Carriera, Leonard M., Rochester, N. Y.
Crocholouser, Larry D., St. Louis, Mo.
Cucra, Frank A., Rochester, N. Y.
Evans, Arthur F., Harrison, N. Y.
Garrett, Jarvin R., Johnson City, Tenn.
Harrison, Ronald A. Jr., St. Louis, Mo.
Hillier, David E., St. John, Mo.
Kirkpatrick, Donald C., St. Louis, Mo.
Thomas, Warren H., Bristol, Va.
Whitlow, George S. Jr., Webster Groves, Missouri
Wichelman, Ronald J., Rochester, N. Y.

clinics, conferences, and courses

JUNE

. . . **5-7—15th Annual Convention and Exhibit, American Society for Quality Control, Hotel Sheraton, Philadelphia, Pa.**

. . . **5-7**—Second Annual Manufacturing Supervisors Short Course—Management Games—Statistical QC—Linear Programming" sponsored by Auburn University, Auburn, Ala., contact E. R. Ashworth, Department of Industrial Management, School of Engineering, Auburn, Ala.

. . . **5-8**—International Instrument-Automation Conference, Royal York Hotel, Toronto, Ontario, Canada, will cover measurement, data processing, and automatic control, sponsored by ISA, contact H. S. Kindler, Instrument Society of America, 530 Wm. Penn Pl., Pittsburgh 19, Pa.

. . . **5-9**—Basic QC Course for the Graphic Arts Industry, Rochester Institute of Technology, Rochester, N.Y., contact Harold Kentner, Director, Extended Services, RIT, Rochester, New York.

. . . **5-16**—Intensive course in Work Design sponsored by the Department of Industrial Engineering and University College, the Adult Education Division, Washington University, St. Louis, Mo. The course will be conducted in the new Engineering Laboratory Building on the campus. Arrangements have been made for participants to be housed in the new, air-conditioned dormitories. Contact University College, Washington University, St. Louis 30, Mo.

. . . **6-8**—International Instrument-Automation Conference, Royal York Hotel, Toronto, Canada, sponsored by the Instrument Society of America. Contact ISA, 313 Sixth Avenue, Pittsburgh 22, Pa.

. . . **7-17**—Design of Experiments Course, Charles R. Hicks, instructor, Purdue University, Lafayette, Ind., contact Statistical Laboratory, Engineering Administration Bldg., Purdue University, Lafayette, Indiana.

. . . **11-23**—Reliability Institute, University of Connecticut. Storrs Conn., contact Richard M. Story, Jr., University of Connecticut, Storrs, Connecticut.

. . . **11-30**—Summer Executive Program, University of California Extension Conference Center, Lake Arrowhead, Calif. Applications may be made by individuals or by companies through Executive Programs, Graduate School of Business Administration, University of California, Los Angeles 24, Calif.

. . . **12-21**—Basic QC Course for the Chemical Industry. Rochester Institute of Technology, Rochester. N.Y., contact Harold Kentner, Director, Extended Services, RIT, Rochester, N.Y.

. . . **13**—Fourth Graduate Summer Program of Statistics in the Health Sciences, June 13 through July 28, University of Minnesota. Persons interested in course work in elementary or advanced statistics, vital records, records management, design of experiments, bioassay, sampling, demography, and statistical aspects of nutrition research, genetics, pharmacology and mathematical models are invited to attend. Stipends are available to qualified students. Experts such as Cochran, Cox, Li, Chiang, Bailey, Patton, and others will be teaching. House, food and course fees will be about $300. Contact Biostatistics, 1226 Mayo, University of Minnesota, Minneapolis 14, Minn.

. **13-16**—Cornell University Seminars in Industrial Engineering, Department of Industrial and Engineering Administration of the Sibley School of Mechanical Engineering, concurrent four-day sessions on industrial management, engineering administration, capital investment planning: theory and practice, operations management of the smaller company, work measurement, systems simulation using digital computers, queuing and inventory theory, statistical decision-making: theory and applications, and statistical reliability analysis: theory and applications. Contact J. W. Gavett, seminars coordinator, Upson Hall, Cornell University, Ithaca, N. Y.

. . . **13-16**—Third International Symposium on Gas Chromatography, Michigan State University, East Lansing, Mich., sponsored by the Instrument Society of America. Contact ISA Meetings Manager, 313 Sixth Avenue, Pittsburgh 22, Pa.

. . . **14**—Plastics in Packaging SPE Regional Technical Conference sponsored by the Quebec section of the international Society at the Sheraton Mount Royal Hotel, Montreal, Quebec. Contact James C. Gillis, RETEC registration chairman, c/o Carlew Chemicals, Ltd., 18 Westminister St., N., Montreal West, Quebec.

. . . **15**—Southern Regional Graduate Summer Session in Statistics, Virginia Polytechnic Institute, Blacksburg, Va., June 15 through July 22. The Virginia Polytechnic Institute, Oklahoma State University, North Carolina State College, and the University of Florida have agreed to operate a continuing program of graduate summer sessions in statistics to be held at each institution in rotation. The session will last six weeks and courses will carry five quarter hours of credit. Not more than two courses may be taken for credit at any one session. The summer work in statistics may be applied as residence credit at any of the cooperating institutions, as well as certain other universities, in partial fulfillment of the requirements for a graduate degree. Courses are statistical methods, sampling theory, applied statistics for engineers and physical scientists; theory I, probability; theory II, statistical inference; theory III, theory of linear hypotheses; non-parametric methods and multivariate methods. A number of courses in advanced mathematics will be available during the summer session. A series of Colloquia involving recent developments in statistical theory and methods will be conducted during the special summer session. Requests for application blanks and for fellowships should be addressed to Dr. Boyd Harshbarger, Head, Department of Statistics, Virginia Polytechnic Institute, Blacksburg, Va.

. . . **19-23—Quality Control Engineering Course sponsored by the ASQC Education and Training Institute with the cooperation of the General Electric Co., at the Hotel Thayer, West Point, N. Y. Since this course will not be repeated, the major objective will be the development of future teachers of Quality Control Engineering. Enrollment has been limited to 30 persons. Applicants will be expected to have a knowledge of statistical quality control as well as experience in Quality Control Engineering Work. Fee $150. Contact ASQC, 161 W. Wisconsin Ave., Milwaukee 3, Wis.**

. . . **19-30**—Tenth Statistics Course, Queen's University, Kingston, Ontario, Canada, sponsored jointly by TAPPI and the Technical Section, Canadian Pulp and Paper Association, contact Douglas Jones, executive secretary, Technical Section, Canadian Pulp and Paper Association, 2280 Sun Life Bldg., Montreal 2, P. Q. Canada.

. . . **19-30**—Probabilistic Methods in the Control of Operations, MIT, contact John I. Mattill, Massachusetts Institute of Technology, Cambridge 39, Mass.

. . . **22-29**—Advanced QC Course for the Chemical Industry, Rochester Institute of

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Technology, Rochester, N.Y., contact Harold Kentner, Director, Extended Services, RIT, Rochester, New York.

. . . **26-30**—Eleventh Annual Program of Quality Control for the Graphic Industries, Towne House Motor Inn, Rochester, N. Y., fee $250, contact Harold M. Kentner, director, Extended Services Division, Rochester Institute of Technology, Rochester 8, N. Y.

. . . **26-30**—Aero-Space Electricity Conference, AIEE, Benjamin Franklin Hotel, Philadelphia, Pa., contact J. A. Scarcelli, General Electric Co., 3198 Chestnut St., Philadelphia, Pa.

. . . **28-30**—Second Joint Automatic Control Conference, University of Colorado campus, Boulder, Colo., sponsored jointly by ISA, AIChE, AIEE, ASME and IRE. General program chairman is H. M. Paynter, Mechanical Engineering Dept., Massachusetts Institute of Technology.

JULY

. . . **10**—Three Week Conference in Transport Phenomena for engineering teachers, a project supported by the National Science Foundation through a recent grant of more than $40,000 to the University of Wisconsin. Transport phenomena includes the subject matter areas of fluid dynamics, heat transfer and diffusional processes. A living and travel allowance will be awarded to teachers on the basis of qualifications contained in applications submitted. The NSF grant provides stipends for approximately 80 participants. Contact Professor Paul J. Grogan, administrative director. Conference on Transport Phenomena, University Extension Department of Engineering, University of Wisconsin, Madison 6, Wis.

. . . **31-Aug. 11**—Statistical Methods in Industry series of seven concurrent courses at the University of California, Los Angeles, Calif. Courses are QC by statistical methods; industrial statistical methods; statistical design and analysis of industrial experiments; probability and statistics of reliability; engineering and management of reliability; basic measurements and standards, and fundamental principles of non-destructive testing. Contact Edward P. Coleman, Professor of Engineering,

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38 characters and spaces per line.

Replies to box numbers and copy should be addressed to American Society for Quality Control, 161 W. Wisconsin Ave., Milwaukee 3, Wis. Deadline is 22nd of second month preceding publication.

POSITIONS WANTED

Have twelve year's experience in organizing and directing quality control activities. This includes the initiation and administration of statistical quality control procedures and sampling plans on both finished product and manufacturing processes; writing quality control reports to management; design and analysis of experiments; representing the company to both customers and suppliers on all matters relative to quality problems; writing and maintaining a Manual of Quality Control Procedures and Specifications; teaching Quality Control at the University Level. Hold an advanced degree in SQC. Am presently employed as Manager of Quality Control. Desire to move to similar position with progressive company. Will relocate. Please reply to Box 17M1.

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Technical graduate with 3-7 years experience in statistical quality control in process industries urgently needed by major industrial plastics manufacturer supplying electrical and electronic fields.
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Midwest manufacturer seeks a man to direct quality control for a medium size plant. Involves inspection of components, final test and approval, necessary methods and procedures, and administration of complaints and returns. Must know modern statistical methods of quality control and have broad experience in the field. Must have electric motor experience, particularly fractional. Degree required. Age preferred 35-45. Commensurate salary. Please reply fully in confidence. Our people know of this opening. Please reply to Box 17Z2.

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AUGUST

. . . **21-31**—Basic QC Course, University of Michigan, Ann Arbor, Mich., contact C. C. Craig, Statistical and Computing Laboratory, 106 Rackham Bldg., University of Michigan, Ann Arbor, Michigan.

. . . **28-Sept. 1**—International Heat Transfer Conference, Boulder, Colorado, contact American Society of Mechanical Engineers, meetings department, 29 W. 39th St., New York 18, New York.

. . . **29-Sept. 1**—66th Summer Meeting of the American Mathematical Society at Oklahoma State University, Stillwater, Okla., contact American Mathematical Society, 190 Hope St., Providence 6, R. I.

SEPTEMBER

. . . **5-15**—Statistical Methods and Advanced QC Course, Irving W. Burr, instructor, Purdue University, Lafayette, Ind., contact Statistical Laboratory, Engineering Administration Bldg., Purdue University, Lafayette, Indiana.

. . . **10-22**—Basic QC Course, University of Connecticut, Storrs, Conn., contact Richard M. Story, Jr., University of Connecticut, Storrs, Connecticut.

. . . **12**—Eighth Annual Bay Area Quality Control Conference, Stanford University, Palo Alto, Calif. Contact W. Grant Ireson, Head, Industrial Engineering Department, Stanford University, Palo Alto, Calif.

. . . **16**—16th Michigan Quality Control Forum, Angel Hall, University of Michigan, Ann Arbor, Mich. Contact Dale A. Cue, Hoover Ball and Bearing Co., 5400 South State Road, Ann Arbor, Mich.

. . . **16—The Scope of Quality Control, Granata Hotel, San Antonio, Texas, sponsored by the San Antonio section, ASQC, contact Robert W. Worrick, 239 E. Ackard Pl., San Antonio 21, Texas.**

. . . **20-21**—Industrial Electronics Symposium, Bradford Hotel, Boston, Mass., sponsored jointly by the AIEE, ISA, and the Professional Group on Industrial Electronics of the IRE. Contact D. J. LaCerda, Badger Manufacturing Co., 363 Third St., Cambridge, Mass.

. . . **28-29—Two-day QC Training Program, University of Chicago, downtown campus, Chicago, Ill., contact J. C. Dittrich, Victor Adding Machine Co., 3900 N. Rockwell St., Chicago 18, Ill.**

. . . **28-30—ASQC Chemical Division Conference, Hotel Daniel Boone, Charleston, W. Va., contact Jack L. Massau, E. I. du Pont de Nemours and Co., P. O. Box 993, Charleston 24, W. Va.**

OCTOBER

. . . **9-11**—National Electronics Conference, International Amphitheatre, Chicago, Ill. Sponsors include the American Institute of Electrical Engineers, Illinois Institute of Technology, Institute of Radio Engineers, Northwestern University, and the University of Illinois. Participants are Electronic Industries Association, the Society of Motion Picture and Television Engineers, Iowa State University, Marquette University, Michigan State University, Purdue University, University of Michigan, University of Notre Dame, University of Wisconsin, and Wayne State University. Contact NEC, 228 N. LaSalle St., Chicago 1, Ill.

. . . **24-25—Product Maintainability Working Seminar, Sheraton Hotel, Philadelphia, Pa., sponsored by the Electronics Division, ASQC. Contact B. W. Marguglio, Martin Co., Mail No. 2000, Baltimore 3, Md.**

NOVEMBER

. . . **9-10—Eleventh Annual Conference of the Aircraft and Missile Division, ASQC, Ambassador Hotel, Los Angeles, Calif., theme—Assuring Customer Satisfaction, four concurrent series of sessions on international and general interest, design—reliability, production—quality control, and field service—maintainability. Contact Hardy Harris, publicity chairman, c/o North American Aviation, Inc., International Airport, Los Angeles 45, Calif.**

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Responsibility of the American Society for Quality Control, Inc., for Consulting Services advertising is limited to certification that advertisers hold the grade of membership in the Society stated in their advertisements. Qualification requirements for the several grades of memberships are set forth in the Constitution of the Society. Business card ads are available only to members of the Society—12 insertions $100.00; 6 insertions $65.00.

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